COMMONWEALTH of VIRGINIA
Board of Education Agenda

Date of Meeting: October 22, 2009 **Time:** 9 a.m.
Location: Jefferson Conference Room, 22nd Floor, James Monroe Building
101 North 14th Street, Richmond, Virginia

9:00 a.m. FULL BOARD CONVENES

Moment of Silence

Pledge of Allegiance

Approval of Minutes of the September 17, 2009, Meeting of the Board

Recognition

- Recognition of the Virginia Museum of Fine Art's Education and Statewide Partnerships Trustee Committee
- Recognition of the Recipients of the National Cyber Security Alliance 2009 K-12 Poster and Video Contest

Public Comment

Consent Agenda

A. Final Review of Financial Report on Literary Fund

B. Final Review of Recommendations Concerning Applications for Literary Fund Loans

C. Final Review of Recommendations Concerning Literary Fund Applications Approved for Release of Fund or Placement on a Waiting List

Action/Discussion Items

D. Final Review of the Standards of Quality

E. First Review of a Revised Memorandum of Understanding for Petersburg City Public Schools to include Compliance with the *Regulations Establishing Standards for Accrediting Public Schools in Virginia* (8 VAC 20-131-315)

Action/Discussion Items (continued)

F. First Review of Report on Career and Technical Education Programs in Petersburg City Public Schools

G. First Review of the Advisory Board on Teacher Education and Licensure's Recommendation Regarding the Certification of Braille Instructors in Response to the Virginia General Assembly House Bill 2224

H. Final Review of the Proposed Revised Curriculum Framework for 2009 *Mathematics Standards of Learning*

I. First Review of the Proposed Revised *English Standards of Learning*

J. First Review of the Proposed Revised *Science Standards of Learning*

K. First Review of the 2008-2009 *Annual Report on Regional Alternative Education Programs*

L. First Review of *Educational Technology Plan for Virginia: 2009-2015*

M. First Review of the Board of Education's 2009 *Annual Report of the Conditions and Needs of Public Schools in Virginia*

Report

N. Annual Report from the Virginia Council for Private Education

DISCUSSION OF CURRENT ISSUES - by Board of Education Members and Superintendent of Public Instruction

EXECUTIVE SESSION

ADJOURNMENT

PUBLIC NOTICE

The Board of Education members will meet for dinner at 6:30 p.m. at the Crowne Plaza Hotel on Wednesday, October 21, 2009. Items for the Board agenda may be discussed informally at that dinner. No votes will be taken, and it is open to the public. The Board president reserves the right to change the times listed on this agenda depending upon the time constraints during the meeting.

GUIDELINES FOR PUBLIC COMMENT

1. The Board of Education is pleased to receive public comment at each of its regular monthly meetings. In order to allow the Board sufficient time for its other business, the total time allotted to public comment will generally be limited to thirty (30) minutes. Individuals seeking to speak to the Board will be allotted three (3) minutes each.

2. Those wishing to speak to the Board should contact Dr. Margaret Roberts, Executive Assistant for Board Relations at (804) 225-2924. Normally, speakers will be scheduled in the order that their requests are received until the entire allotted time slot has been used. Where issues involving a variety of views are presented before the Board, the Board reserves the right to allocate the time available so as to ensure that the Board hears from different points of view on any particular issue.

3. Speakers are urged to contact Dr. Roberts in advance of the meeting. Because of time limitations, those persons who have not previously registered to speak prior to the day of the Board meeting cannot be assured that they will have an opportunity to appear before the Board.

4. In order to make the limited time available most effective, speakers are urged to provide multiple written copies of their comments or other material amplifying their views.

Board of Education Agenda Item

Item: A. **Date:** October 22, 2009

Topic: Final Review of Financial Report on Literary Fund

Presenter: Mr. Kent C. Dickey, Assistant Superintendent for Finance

Telephone Number: (804) 225-2025 **E-Mail Address**: Kent.Dickey@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

_X_ Action requested at this meeting _____ Action requested at future meeting: _____ (date)

Previous Review/Action:

_X_ No previous board review/action

____ Previous review/action
date _____
action _____

Background Information:

In accordance with the provisions of the *Code of Virginia*, Chapter 10, Section 22.1-142, the Board of Education is responsible for the management of the Literary Fund. This report reflects the status of the Literary Fund and the status of the Reserve Fund, which is in the custody of the Virginia Public School Authority (VPSA). The report also reflects the total principal of the fund, as well as cash, investments, and all short-/long-term loans in both funds.

Summary of Major Elements

Attachment A reflects the financial position of the Literary Fund as of June 30, 2009. The information presented in this report reflects the commitments against the Literary Fund as of June 30, 2009.

Attachment B reflects the currently active projects funded through the Literary Fund as of June 30, 2009.

Attachment C represents the projects that have closed and for which full payment from the Literary Fund has been made since the last Board meeting.

Superintendent's Recommendation:

The Superintendent of Public Instruction recommends approval of the financial report (including all statements) on the status of the Literary Fund as of June 30, 2009.

Impact on Resources:

As funds become available in the Literary Fund, recommendations will be made to the Board for funding priority projects and those projects at the top of the First Priority Waiting List, with the cash balance reduced as loan requests are processed.

Timetable for Further Review/Action:

The Department staff will prepare a quarterly financial report on this fund for Board approval. Information also will be presented each quarter, as part of another agenda item, regarding those projects on the two waiting lists.

Attachment A

STATEMENT OF THE FINANCIAL POSITION OF THE LITERARY FUND
(as of June 30, 2009)

Line Reference		June 30, 2009	March 31, 2009	Increase/(Decrease)
	PRINCIPAL BALANCE			
1.	Cash and investments maintained by State Treasurer	52,478,676	253,568,479	(201,089,803)
2.	Temporary loans received from local school boards (secured by promissory notes)	0	7,500,000	(7,500,000)
3.	Cash and investments in custody of Virginia Public School Authority (VPSA)[1]	0	0	0
4.	Long-term loans in custody of Virginia Public School Authority (VPSA)	312,050,993	308,778,567	3,272,426
5.	Total Principal of Literary Fund	**364,529,669**	**569,847,046**	(205,317,377)
	CURRENT COMMITMENTS AGAINST LITERARY FUND REVENUE			
6.	Balance due on active projects (Attachment B)	22,399,121	25,091,935	(2,692,814)
7.	Debt service on VPSA equipment notes	0	60,536,725	(60,536,725)
8.	Interest rate subsidy	0	0	0
9.	Trigon Reserve	5,657,429	5,657,429	0
10.	Transfer for Teacher Retirement	0	228,691,828	(228,691,828)
11.	Other encumbrances held by Treasurer of Virginia[2]	0	10,234	(10,234)
12.	Required Carry Forward Balance	64,469,470	64,469,470	0
13.	Total of Literary Fund Commitments	**92,526,020**	**384,457,620**	(291,931,601)
	FUNDS AVAILABLE FOR CURRENT COMMITMENTS AND NEW LOANS			
14.	Cash and investments maintained by State Treasurer (Line 1)	52,478,676	253,568,479	
15.	Less commitments against Literary Fund Revenues (Line 13)	(92,526,020)	(384,457,620)	
16.	**Balance Available to Fund New Projects Currently on Waiting List or (Additional Funds Needed to Meet Commitments)**	**(40,047,344)**	**(130,889,141)**	

NOTES:

[1]After June 30, 2009, Line 3 above, "Cash and investments in custody of Virginia Public School Authority (VPSA)," is no longer applicable and will be removed from future board agenda items.

[2]After June 30, 2009, Line 11 above, "Other encumbrances held by Treasurer of Virginia," is no longer applicable and will be removed from future board agenda items.

October, 2009

Attachment B

ACTIVE LITERARY FUND PROJECTS (as of June 30, 2009)

Application Number	School Division	School	Release Date	Funds Approved for Release	Actual Funds Disbursed	Balance Due	Percent Drawn
Literary Loans							
11254	Southampton County	Riverdale Elementary	January, 2008	7,500,000	-	7,500,000	0.00%
11261	Culpeper County	New Elementary	January, 2008	7,500,000	-	7,500,000	0.00%
				$ 15,000,000	**$ -**	**$ 15,000,000**	
Subsidy Grants							
11062	Chesapeake City	Butts Road Intermediate	2001 Subsidy	85,594	(77,881)	7,713	90.99%
11099	Washington County	Patrick Henry High	2003 Subsidy	30,181	(10,162)	20,020	33.67%
11100	Washington County	Valley Institute	2003 Subsidy	5,861	-	5,861	0.00%
11151	Nottoway County	Blackstone Primary	2004 Subsidy	54,632	(40,393)	14,239	73.94%
11150	Nottoway County	Crewe Primary	2004 Subsidy	191,790	(161,572)	30,218	84.24%
11181	Grayson County	Grayson Middle	2005 Subsidy	138,831	-	138,831	0.00%
11201	Portsmouth City	Park View Elementary	2006 Subsidy	1,331,227	(6,500)	1,324,727	0.49%
11210	Halifax County	Halifax Middle	2006 Subsidy	1,331,227	(1,097,125)	234,102	82.41%
11220	Halifax County	South Boston Elementary	2006 Subsidy	641,739	(227,676)	414,063	35.48%
11212	Washington County	Abingdon Elementary	2007 Subsidy	201,358	(6,500)	194,858	3.23%
11213	Washington County	High Point Elementary	2007 Subsidy	154,739	-	154,739	0.00%
11214	Washington County	Valley Institute Elementary	2007 Subsidy	123,197	-	123,197	0.00%
11215	Washington County	E. B. Stanley Middle	2007 Subsidy	149,896	-	149,896	0.00%
11258	Gloucester County	Abingdon Elementary School	2007 Subsidy	798,438	(773,560)	24,878	96.88%
11262	Wise County	Coeburn Middle School	2008 Subsidy	631,973	-	631,973	0.00%
11263	Wise County	Powell Valley Primary School	2008 Subsidy	726,322	-	726,322	0.00%
11255	Roanoke City	William Fleming High School	2008 Subsidy	1,006,140	-	1,006,140	0.00%
11272	Town of West Point	West Point High School	2008 Subsidy	64,219	(6,500)	57,719	10.12%
11273	Town of West Point	West Point Middle School	2008 Subsidy	41,984	-	41,984	0.00%
11270	Rockingham County	New Elementary School in Elkton	2008 Subsidy	999,640	(726,705)	272,935	72.70%
11293	Tazewell County	Richlands Elementary School	2008 Subsidy	446,045	-	446,045	0.00%
11294	Tazewell County	Tazewell Elementary School	2008 Subsidy	483,392	-	483,392	0.00%
11295	Tazewell County	Springville Elementary School	2008 Subsidy	243,178	-	243,178	0.00%
11296	Tazewell County	North Tazewell Elementary School	2008 Subsidy	324,368	-	324,368	0.00%
11297	Tazewell County	Cedar Bluff Elementary School	2008 Subsidy	327,724	-	327,724	0.00%
				$ 25,533,695	**$ (3,134,574)**	**$ 22,399,121**	

October, 2009

Attachment C

LITERARY FUND PROJECT REIMBURSEMENTS COMPLETED (as of June 30, 2009)

Application Number	School Division	School	Release Date	Funds Approved for Release	Actual Funds Disbursed	Funds Returned	Balance Due	Percent Drawn
11098	Washington County	Holston High	2003 Subsidy	20,949	(20,949)	-	-	**100.00%**
11097	Washington County	John S. Battle High	2003 Subsidy	30,210	(30,210)	-	-	**100.00%**
11228	Roanoke County	Northside High School	2007 Subsidy	798,438	(798,438)	-	-	**100.00%**
11271	Rockingham County	New High School in Elkton	2008 Subsidy	1,006,140	(1,006,140)	-	-	**100.00%**
				$ 1,855,736	$ (1,855,736)	$ -	$ -	

October, 2009

Board of Education Agenda Item

Item: B. **Date:** October 22, 2009

Topic: Final Review of Recommendations Concerning Applications for Literary Fund Loans

Presenter: Mr. Kent C. Dickey, Assistant Superintendent for Finance

Telephone Number: (804) 225-2025 **E-Mail Address:** Kent.Dickey@doe.virginia.gov

Origin:

_____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- _____ Board of Education regulation
- _____ Other: _____

_X_ Action requested at this meeting _____ Action requested at future meeting: _____ (date)

Previous Review/Action:

_X_ No previous board review/action

_____ Previous review/action
date _____
action _____

Background Information:

The recommendation for approval of the projects on Attachment A is in accordance with the *Code of Virginia*, Chapter 10, Section 22.1-146, which authorizes the Board of Education to make loans from the Literary Fund for the purpose of erecting, altering, or enlarging school buildings. Approval of an application constitutes the first step in a two-step process to secure a loan from the Literary Fund. The second step can occur only after Departmental receipt of final plans and specifications per Section 22.1-140 of the *Code of Virginia*, coupled with a written request to the Department for release of funds, with the latter request also requiring Board approval.

Summary of Major Elements:

Attachment A reflects two (2) applications that have been reviewed by the Department. These applications have met all of the Board requirements necessary to be approved for a Literary Fund loan.

Superintendent's Recommendation:

The Superintendent of Public Instruction recommends approval of the two (2) applications totaling $7,979,954 (Attachment A).

Impact on Resources:

There will be no impact on the resources of the Literary Fund until a locality receives approval from the Board of Education for the release of funds, construction begins on the approved project, and a request for reimbursement is submitted and approved.

Timetable for Further Review/Action:

Recommendations similar to Attachment A will be presented to the Board on a quarterly basis as needed, if found in proper order after review by the Department.

BOARD OF EDUCATION

LITERARY FUND LOAN APPLICATIONS PRESENTED FOR APPROVAL

It is recommended that the following applications be approved:

Literary Fund #	School Division	School	Date Received	Amount	Comment
11313	Virginia Beach City	College Park Elementary School	July 9, 2009	4,879,954	New Construction (Plans Not Received)
11314	Washington County	William N. Neff Center	August 3, 2009	3,100,000	Addition and Renovation (Plans Received)

Total: $ 7,979,954

October, 2009

Board of Education Agenda Item

Item: C. **Date:** October 22, 2009

Topic: Final Review of Recommendations Concerning Literary Fund Applications Approved for Release of Funds or Placement on a Waiting List

Presenter: Mr. Kent C. Dickey, Assistant Superintendent for Finance

Telephone Number: (804) 225-2025 **E-Mail Address**: Kent.Dickey@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

_X_ Action requested at this meeting ____ Action requested at future meeting: _____ (date)

Previous Review/Action:

_X_ No previous board review/action
____ Previous review/action
date _____
action _____

Background Information:

The Literary Fund regulations of the Board establish two priorities for the Literary Fund Waiting Lists. These priorities are as follows:

Priority 1: Applications from localities having a composite index less than 0.6000 and indebtedness (including the application considered for release of funds) less than $20 million to the Literary Fund (Attachment A).

Priority 2: Applications from localities having a composite index of 0.6000 or above or an indebtedness (including the application considered for release of funds) of $20 million or greater to the Literary Fund (Attachment B).

Attachment C lists the projects that have been removed from the First Priority Waiting List.

Attachment D identifies the Literary Fund applications that are available for release.

Attachment E is the Board of Education's current Approved Application List. This attachment identifies the Literary Fund applications that are approved as to form but are not included on either waiting list and are not recommended for funding.

Summary of Major Elements:

To the extent funds are available, a recommendation for initial release of funds is presented for projects currently on the First Priority Waiting List or otherwise eligible for priority funding. To the extent funds are not available, new requests for the initial release of Literary Funds cannot be approved. As a result, such requests must be deferred and placed on either the First or Second Priority Waiting List in accordance with the Literary Fund regulations.

This item consists of the two elements that require action by the Board of Education. These elements are:

1. Eight new projects, totaling $10,110,035, listed on Attachment A, are eligible for placement on the First Priority Waiting List.

2. One new project, totaling $4,879,954, listed on Attachment E, has a Literary Fund application, which is approved as to form, but the plans have not yet been finalized. When the Department receives the plans, this project will be eligible for placement on a waiting list. Until such time, this project should remain on the Approved Application List.

Superintendent's Recommendation:

The Superintendent of Public Instruction recommends that the Board of Education approve the action described in these two elements listed under "Summary of Major Elements."

Impact on Resources:

Current Board policy provides that, upon initial release of funds, Literary Fund cash is reduced in the total amount of the approved loan to assure that cash is available as required for project completion. The disbursement of funds is based on actual invoices or other evidence of bills due and payable from the Literary Fund.

Timetable for Further Review/Action:

The staff will prepare items for the Board on this action as needed. Based on the availability of funds, initial release of funds will be made or projects will be deferred and placed on the Waiting Lists.

VIRGINIA BOARD OF EDUCATION - LITERARY FUND FIRST PRIORITY WAITING LIST

The following projects have been placed or are recommended for placement on the First Priority Waiting List with the actions as indicated in the last column. Projects recommended for action at this meeting are presented in italics.

Priority	Date Placed on Waiting List	School Division	School	Interest Rate	Amount	Cumulative Total	Action/Status
1	July, 2007	Pulaski County	Riverlawn Elementary School	2%	7,500,000	7,500,000	Funding Deferred
2	October, 2007	Manassas Park City	Cougar Upper Elementary School	3%	7,500,000	15,000,000	Funding Deferred
3	October, 2007	Covington City	Jeter Watson Intermediate School	2%	7,500,000	22,500,000	Funding Deferred
4	October, 2007	Covington City	Edgemont Primary School	2%	7,500,000	30,000,000	Funding Deferred
5	October, 2007	Prince George County	North Elementary School	2%	7,500,000	37,500,000	Funding Deferred
6	July, 2008	Petersburg City	Robert E. Lee Elementary School	2%	6,493,700	43,993,700	Funding Deferred
7	July, 2008	Petersburg City	Walnut Hill Elementary School	2%	5,818,691	49,812,391	Funding Deferred
8	July, 2008	Norton City	Norton Elementary School	3%	7,500,000	57,312,391	Funding Deferred
9	July, 2008	Portsmouth City	Simonsdale Elementary School	2%	7,500,000	64,812,391	Funding Deferred
10	July, 2008	Lynchburg City	Sandusky Middle School	3%	7,500,000	72,312,391	Funding Deferred
11	July, 2008	Northampton County	Northampton High School	3%	7,500,000	79,812,391	Funding Deferred
12	July, 2008	Lee County	Dryden Elementary School	2%	2,300,000	82,112,391	Funding Deferred
13	July, 2008	Grayson County	West Grayson Elementary School	2%	7,500,000	89,612,391	Funding Deferred
14	October, 2008	Pittsylvania County	Tunstall High School	2%	7,500,000	97,112,391	Funding Deferred
15	October, 2008	Pittsylvania County	Chatham High School	2%	7,500,000	104,612,391	Funding Deferred
16	October, 2008	Wythe County	Rural Retreat High School	2%	7,500,000	112,112,391	Funding Deferred
17	October, 2008	Wythe County	Rural Retreat Middle School	2%	2,600,000	114,712,391	Funding Deferred
18	October, 2008	Montgomery County	New Elliston-Lafayette & Shawsville Elementary School	3%	7,500,000	122,212,391	Funding Deferred
19	January, 2009	Lexington City	Lylburn Downing Middle School	3%	7,500,000	129,712,391	Funding Deferred
20	January, 2009	Warren County	Luray Avenue Middle School	3%	7,500,000	137,212,391	Funding Deferred
21	January, 2009	Grayson County	Fries Elementary School	2%	7,500,000	144,712,391	Funding Deferred
22	January, 2009	Henry County	Fieldale Collinsville Middle School	2%	2,500,000	147,212,391	Funding Deferred
23	January, 2009	Henry County	Magna Vista High School	2%	7,200,000	154,412,391	Funding Deferred
24	January, 2009	Richmond County	Richmond County Elementary School	3%	4,250,000	158,662,391	Funding Deferred
25	January, 2009	Richmond County	Rappahannock High School	3%	250,000	158,912,391	Funding Deferred
26	April, 2009	Giles County	Giles County Technology Center	2%	7,500,000	166,412,391	Funding Deferred
27	April, 2009	Giles County	Eastern Elementary/Middle School	2%	7,500,000	173,912,391	Funding Deferred
28	April, 2009	Nottoway County	Blackstone Primary School	2%	666,667	174,579,058	Funding Deferred
29	April, 2009	Nottoway County	Crewe Primary School	2%	666,667	175,245,725	Funding Deferred
30	April, 2009	Nottoway County	Burkeville Elementary School	2%	666,666	175,912,391	Funding Deferred
31	April, 2009	Fluvanna County	Fluvanna County High School	3%	7,500,000	183,412,391	Funding Deferred
32	July, 2009	Virginia Beach City	Great Neck Middle School	3%	7,500,000	190,912,391	Funding Deferred
New projects to be added with funding deferred until funds are approved for release by separate action of the Board of Education							
33	*October, 2009*	*Washington County*	*John Battle High School*	*3%*	*489,126*	*191,401,517*	*Funding Deferred*
34	*October, 2009*	*Washington County*	*Abingdon High School*	*3%*	*489,126*	*191,890,643*	*Funding Deferred*
35	*October, 2009*	*Washington County*	*Patrick Henry High School*	*3%*	*1,177,236*	*193,067,879*	*Funding Deferred*
36	*October, 2009*	*Washington County*	*Holston High School*	*3%*	*602,186*	*193,670,065*	*Funding Deferred*
37	*October, 2009*	*Washington County*	*Meadowview Elementary School*	*3%*	*1,491,288*	*195,161,353*	*Funding Deferred*
38	*October, 2009*	*Washington County*	*Wallace Middle School*	*3%*	*1,165,073*	*196,326,426*	*Funding Deferred*
39	*October, 2009*	*Washington County*	*Glade Spring Middle School*	*3%*	*1,596,000*	*197,922,426*	*Funding Deferred*
40	*October, 2009*	*Washington County*	*William N. Neff Center*	*3%*	*3,100,000*	*201,022,426*	*Funding Deferred*

October, 2009

VIRGINIA BOARD OF EDUCATION - LITERARY FUND SECOND PRIORITY WAITING LIST

The following projects have been placed or are recommended for placement on the Second Priority Waiting List with the actions as indicated in the last column. Projects recommended for action at this meeting are presented in italics.

Priority	Date Placed on Waiting List	School Division	School	Interest Rate	Amount	Cumulative Total	Action/Status	Comments
1	October, 2008	Pittsylvania County	Dan River High School	2%	7,500,000	7,500,000	Funding Deferred	
2	October, 2008	Pittsylvania County	Gretna High School	2%	7,500,000	15,000,000	Funding Deferred	

October, 2009

VIRGINIA BOARD OF EDUCATION - REMOVAL FROM FIRST PRIORITY WAITING LIST

The following projects have been removed from the First Priority Waiting List with the actions as indicated in the last column.

Date Placed on Waiting List	School Division	School	Interest Rate	Amount	Cumulative Total	Action/Status

NO PROJECTS

October, 2009

VIRGINIA BOARD OF EDUCATION - RELEASE OF LITERARY FUNDS

It is recommended that Literary Funds be released for the following projects on the first priority waiting list.

Date Placed on Waiting List	School Division	School	Interest Rate	Amount	Cumulative Total

NO PROJECTS

October, 2009

LITERARY FUND OF VIRGINIA

APPROVED APPLICATION LIST [1]

Priority	Date Placed on Application List	School Division	School	Interest Rate	Application Amount	Cumulative Total	Action/Status
1	April, 2008	Alleghany County	Alleghany High School	2%	7,500,000	7,500,000	Pending receipt of plans
2	January, 2009	Hopewell City	Hopewell High School	2%	7,500,000	15,000,000	Pending receipt of plans
3	July, 2009	Buckingham County	Dillwyn Lower Elementary School	2%	7,500,000	22,500,000	Pending receipt of plans
New projects to be added to the approved application list							
4	*October, 2009*	*Virginia Beach City*	*College Park Elementary School*	*3%*	*4,879,954*	*27,379,954*	*Pending receipt of plans*

[1] Reflects only those applications not on waiting lists

Note: Per 8VAC20-100-90, applications which remain on the approved application list for three years shall be removed from the list.

October, 2009

Board of Education Agenda Item

Item: D. **Date:** October 22, 2009

Topic: Final Review of the Standards of Quality

Presenter: Ms. Anne D. Wescott, Assistant Superintendent for Policy and Communications

Telephone Number: (804) 225-2403 **E-Mail Address:** Anne.Wescott@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

_X_ Action requested at this meeting ___ Action requested at future meeting: _____

Previous Review/Action:

___ No previous board review/action

_X_ Previous review/action

date September 17, 2009

action First review of the Standards of Quality

Background Information: Article VIII, § 2 of the *Constitution of Virginia* requires the Board of Education to determine and prescribe Standards of Quality for the public schools in Virginia. The *Constitution* says:

> "Standards of quality for the several school divisions shall be determined and prescribed from time to time by the Board of Education, subject to revision only by the General Assembly. The General Assembly shall determine the manner in which funds are to be provided for the cost of maintaining an educational program meeting the prescribed standards of quality, and shall provide for the apportionment of the cost of such program between the Commonwealth and the local units of government comprising such school divisions. Each unit of local government shall provide its portion of such cost by local taxes or from other available funds."

The *Code of Virginia* requires the Board of Education to review the Standards of Quality every two years. Section 22.1-18.01 of the *Code* says, in part:

> "To ensure the integrity of the standards of quality, the Board of Education shall, in even-numbered years, exercise its constitutional authority to determine and prescribe the standards, subject to revision only by the General Assembly, by reviewing the standards and either (i) proposing amendments to the standards or (ii) making a determination that no changes are necessary…."

The *Code* also requires that the Board's annual report to the Governor and General Assembly include any recommendations for revisions to the Standards of Quality. Section 22.1-18 of the *Code* says, in part:

> "…the Board of Education shall submit to the Governor and the General Assembly a report on the condition and needs of public education in the Commonwealth and shall identify any school divisions and the specific schools therein which have failed to establish and maintain schools meeting the existing prescribed standards of quality. Such standards of quality shall be subject to revision only by the General Assembly, pursuant to Article VIII, Section 2 of the Constitution of Virginia. Such report shall include a complete listing of the current standards of quality for the Commonwealth's public schools, together with a justification for each particular standard, how long each such standard has been in its current form, and whether the Board recommends any change or addition to the standards of quality."

The 2009 General Assembly added language to Item 140 of the Appropriation Act that says:

> "The Board of Education shall review the current Standards of Quality to evaluate the appropriateness of the existing staffing standards for instructional positions and the appropriateness of establishing ratio standards for support positions, with the objective of maximizing resources devoted to the instructional program. The findings of this review, its associated costs, and its final recommendations for rebenchmarking shall be submitted to the Governor, the Chairmen of House Appropriations and Senate Finance Committees and the Joint Subcommittee on Elementary and Secondary Education Funding established pursuant to Item 1, paragraph H. of this Act no later than November 1, 2009."

The Board of Education approved the work plan for this review on April 30. The work plan includes:

- Participation and involvement of education entities and the public;
- Collection and analysis of data provided by school divisions;
- Research and analysis by an outside independent consultant;
- Examination of all facets of the Standards of Quality (SOQ) staffing standards;
- Identification of best practices; and
- Formulation of recommendations.

The review was conducted by the Board's Standing Committee of the Standards of Quality, chaired by

Mrs. Saslaw. The committee met on May 27, June 24, July 22, September 16, and October 21. During these meetings, the committee heard from a number of educational organizations, school divisions, parents, teachers, students, and other members of the public.

The first public comment period was May 1 through July 31. The Board received 31 comments at the SOQ Committee meetings; a petition from JustChildren in partnership with the Alliance for Virginia's Students with 1,130 signatures and comments; five comments at Board of Education meetings; and 14 comments via mail or e-mail from school divisions; organizations, and individuals.

The second public comment period was September 15 through October 2. Four public hearings were held in Chesapeake, Fairfax County, Pulaski County, and Richmond on September 30. There were 92 comments from the four public hearings and 206 comments via mail or e-mail from school divisions, organizations, and individuals. In addition, the Alliance for Virginia's Children presented the petition noted above with an additional 215 signatures.

A summary of the public comments may be found in the attached report.

The SOQ Committee received an interim analysis from Augenblick, Palaich, and Associates, Inc. on staffing standards on July 22, and a final analysis on September 16. A copy of the final analysis may be found in the attached report.

The committee also heard a presentation on rebenchmarking costs estimated for 2010-2012, and received the results of a survey of school divisions at the July 22nd meeting. This information may also be found in the attached report.

At the September 16 SOQ meeting, the Board considered three documents: *Draft Recommended Policy Directions and Options for Revisions to the Standards of Quality*, a chart detailing the policy directions and options for revisions of the SOQ, and draft legislation to amend the Standards of Quality.

At the Board meeting on September 17, the Board approved two additions to the *Draft Recommended Policy Directions and Options for Revisions to the Standards of Quality:*

- Support the appropriateness of establishing ratio standards for individual categories of "support service" positions as is the current practice used for instructional personnel.
- Advocate against permanent structural changes to the Standards of Quality that result in decreased funding for K-12 public education.

Summary of Major Elements: The draft Standards of Quality report to the General Assembly is attached. It includes proposed policy directions, options for revisions to the Standards of Quality, and issues for further study, which are as follows:

Policy Directions

- Enhance the Standards of Quality so that the Commonwealth's basic foundation program for K-12 public education reflects a comprehensive educational program of the highest quality.
- Provide clarity and greater transparency in SOQ funding with the goal of maintaining the Commonwealth's commitment to public education funding at the state and local levels and encouraging a continued emphasis on school-based instructional services.
- Provide greater flexibility to school divisions in using noninstructional personnel funding for instructional support services.
- Support the appropriateness of establishing ratio standards for individual categories of "support service" positions as is the current practice used for instructional personnel.
- Advocate against permanent structural changes to the Standards of Quality that result in decreased funding for K-12 public education.
- Begin building a more comprehensive basic foundation program by including in the SOQ gifted, special education, and career and technical staffing ratios and certain incentive programs that have become core components of K-12 educational programs statewide and currently funded in the appropriations act.
- Set priorities for the Board's unfunded SOQ recommendations from previous years so that these instructional staffing standards can be fully implemented in future years.
- Begin to address the Board's school leadership priorities of requiring a principal in every school and increasing the number of assistant principals in schools with the greatest need.
- Mitigate the perverse incentive of reducing a school division's special education funding when it mainstreams students with disabilities into general education classrooms or uses Response to Intervention (RtI) and/or other instructional supports to reduce the number of students identified as needing special education services.
- Provide additional policy guidance and direction to school divisions offering alternative or nontraditional educational programs, such as the Individual Student Alternative Education Plan (ISAEP).

SOQ Language Revisions to Address Policy Directions

- Codify the Board of Education's recommendations that were included in the 2009 Appropriation Act providing flexibility in the use of existing funds for hiring reading specialists, mathematics specialists, data coordinators, and instruction of English language learners.
- Codify the provisions of the Early Intervention Reading Initiative and the Algebra Readiness program by including them in the Standards of Quality and requiring all school divisions to provide these interventions with funding currently appropriated for these incentive programs.
- Codify the appropriation act provision that the Standards of Quality includes a minimum of 58 licensed, full-time instructional positions per 1,000 students, including instructional positions for special education, gifted education, and career and technical education.
- Codify the staffing standards for special education (currently in regulations), gifted education (currently in the appropriation act), and career and technical education (currently in regulations).

- Provide school divisions the flexibility to deploy assistant principals to the schools with the greatest needs, so long as they employ a sufficient number of assistant principals divisionwide to meet the total number required in the current SOQ staffing requirement.
- Define the categories of personnel who make up "support services," specify how those positions are funded, and require transparency in the use of funds by mandating divisions publicly report the state and local amounts budgeted and expended for each category.
- Permit school divisions to use funds for support services to provide additional instructional services and include instructional services as a separate category to be reported publicly.

Issues for Further Study

As resources become available, conduct a comprehensive study of the following complex funding issues and report the findings to the Governor and General Assembly for consideration as part of the 2010 review of the SOQ.

- The feasibility of converting the prevailing costs for each major category of the "support services" positions into ratios (for example, based on positions per 1,000 students), and including ratios for some or all of the categories in the appropriation act.
- The feasibility of establishing alternative staffing approaches to provide school divisions with additional instructional resources to address identified needs. This could include ratios based on positions per 1,000 students for assistant principals, school counselors, and library-media specialists that would reduce funding "cliffs." It could also include assigning weights for students who may be at-risk and require additional support, including special education services, services to English language learners, and services to disadvantaged students.
- The feasibility of creating a special education incentive fund or other funding methodologies to mitigate the perverse incentive of reducing a school division's special education funding when it mainstreams students with disabilities into general education classrooms or uses Response to Intervention (RtI) and/or other instructional supports to reduce the number of students identified as needing special education services.
- The feasibility of updating technology staffing ratios, taking into consideration the increased role of technology in instruction, assessment, and operations since staffing standards were first established in the SOQ.
- The feasibility of updating career and technical education staffing ratios, taking into consideration the (i.) implementation of new curricular pathways that require high-tech equipment and specialized instruction and (ii.) anticipated increased enrollments in CTE courses given the newly created standard technical and advanced technical diplomas.

One change is proposed to the September 17 draft amendments to Standard 2 of the Standards of Quality (§ 22.1-253.13:2 of the *Code of Virginia*): Clarifying language would be added to the provisions related to special education to define Levels I and Level II services. The definitions are taken from the definitions in the Board's *Regulations Governing Special Education Programs for Children with Disabilities in Virginia* (8 VAC 20-81-10), effective July 7, 2009.

> Each local school board shall employ licensed, full-time equivalent positions in necessary to comply with the following requirements for special education services for students *requiring either Level I or Level II services. Level I services, means the provision of special education to*

children with disabilities for less than 50 percent of their instructional school day (excluding intermission for meals). Level II services, means the provision of special education and related services to children with disabilities for 50 percent or more of the instructional school day (excluding intermission for meals). The time that a child receives special education services is calculated on the basis of special education services described in the individualized education program, rather than the location of services.

The proposed amendments to the Standards of Quality may be found in Attachment 1. The draft Standards of Quality report may be found in Attachment 2.

Superintendent's Recommendation: The Superintendent of Public Instruction recommends that the Board approve the attached report on the Standards of Quality, the proposed policy directions, and the recommended amendments to the Standards of Quality.

Impact on Resources: It is not expected that this proposal will have a significant impact on state and local resources.

Timetable for Further Review/Action: Following the Board's adoption, the report will be transmitted to the Governor and the General Assembly, as required by Item 140.C.5.k.3) of Chapter 781, 2009 Acts of Assembly.

ATTACHMENT 1

Proposed Amendments to the Standards of Quality

Codify the Board of Education's recommendations that were included in the 2009 Appropriation Act providing flexibility in the use of existing funds for hiring reading specialists, mathematics specialists, data coordinators, and instruction of English language learners.

Reading Specialists: *To provide flexibility in the provision of reading intervention services, school divisions may use the state Early Reading Intervention initiative funding and the required local matching funds, pursuant to § 22.1-253.13, paragraph D, 12, to employ reading specialists to provide the required reading intervention services. School divisions using the Early Reading Intervention Initiative funds in this manner shall only employ instructional personnel licensed by the Board of Education.*

Mathematics Specialists: *To provide flexibility in the provision of mathematics intervention services, school divisions may use the state Standards of Learning Algebra Readiness initiative funding and the required local matching funds, pursuant to § 22.1-253.13, paragraph D, 12, to employ mathematics teacher specialists to provide the required mathematics intervention services. School divisions using the Standards of Learning Algebra Readiness initiative funding in this manner shall only employ instructional personnel licensed by the Board of Education.*

Data Coordinators: *To provide flexibility, school divisions may use the state and local funds for instructional technology resource teachers to employ a data coordinator position, an instructional technology resource teacher position, or a data coordinator/instructional resource teacher blended position. The data coordinator position is intended to serve as a resource to principals and classroom teachers in the area of data analysis and interpretation for instructional and school improvement purposes, as well as for overall data management and administration of state assessments. School divisions using these Standards of Quality funds in this manner shall only employ instructional personnel licensed by the Board of Education.*

Instruction of English Language Learners: *To provide flexibility in the instruction of English Language Learners who have limited English proficiency and who are at risk of not meeting state accountability standards, school divisions may use state and local funds from the Standards of Quality Prevention, Intervention, and Remediation account to employ additional English Language Learner teachers to provide instruction to identified limited English proficient students Using these funds in this manner is intended to supplement the instructional services provided through the Standards of Quality staffing standard of 17 instructional positions per 1,000 limited English proficiency students. School divisions using the Standards of Quality Prevention, Intervention, and Remediation funds in this manner shall only employ instructional personnel licensed by the Board of Education.*

Codify the provisions of the Early Intervention Reading Initiative and the Algebra Readiness program by including them in the Standards of Quality and requiring all school divisions to provide these interventions with funding currently appropriated for these incentive programs.

Early Reading: *Local school divisions shall provide early reading intervention services to students in grades kindergarten through 3 who demonstrate deficiencies based on their individual performance on any diagnostic test which has been approved by the Department of Education. School divisions shall report the results of the diagnostic tests to the Department of Education on an annual basis at a time to be determined by the Superintendent of Public Instruction. Each student who receives an intervention will be assessed again at the end of that school year. Such intervention programs, at the discretion of the local school division, may include, but not be limited to, the use of: special reading teachers; trained aides; volunteer tutors under the supervision of a certified teacher; computer-based reading tutorial programs; aides to instruct in-class groups while the teacher provides direct instruction to the students who need extra assistance; or extended instructional time in the school day or year for these students.*

Algebra Readiness: *Local school divisions shall also provide mathematics intervention services to students in grades 6, 7, 8 and 9 who are at risk of failing the Algebra I end-of-course test, as demonstrated by their individual performance on any diagnostic test which has been approved by the Department of Education. School divisions shall report the results of the diagnostic tests to the Department of Education on an annual basis at a time to be determined by the Superintendent of Public Instruction. Each student who receives an intervention will be assessed again at the end of that school year.*

Codify the appropriation act provision that the Standards of Quality would include a minimum of 58 licensed, full-time instructional positions per 1,000 students, including instructional positions for special education, gifted education, and career and technical education.

Each local school board shall employ with state and local basic *aid*, special education, gifted, and career and technical education funds a minimum ~~*number*~~ of *58* licensed, full-time equivalent instructional personnel for each 1,000 students in average daily membership (ADM) as set forth in the appropriation act.

Codify the staffing standards for special education (currently in regulations), gifted education (currently in the appropriation act), and career and technical education (currently in regulations).

Special Education: *Each local school board shall employ licensed, full-time equivalent positions in necessary to comply with the following requirements for special education services* **[*for students requiring either Level I or Level II services. Level I services, means the provision of special education to children with disabilities for less than 50 percent of their instructional school day (excluding intermission for meals). Level II services, means the provision of special education and related services to children with disabilities for 50 percent or more of the instructional school day (excluding intermission for meals). The time that a child receives special education services is calculated on the basis of special education services described in the individualized education program, rather than the location of services.*]**

Local school division caseload maximums as funded by the Virginia Appropriation Act

Disability Category	*Level II*		*Level I*
	With Paraprofessional 100% of the time	*Without Paraprofessional 100% of the Time*	
Autism	*8*	*6*	*24*
Deaf-blindness	*8*	*6*	
Developmental Delay: age 5-6	*10*	*8*	
Developmental Delay: age 2-5	*8 Center-based 10 Combined*	*12 Home-based and/or Itinerant*	
Emotional Disability	*10*	*8*	*24*
Hearing Impairment/Deaf	*10*	*8*	*24*
Learning Disability	*10*	*8*	*24*
Intellectual Disability	*10*	*8*	*24*
Multiple Disabilities	*8*	*6*	
Orthopedic Impairment	*10*	*8*	*24*
Other Health Impaired	*10*	*8*	*24*
Speech or Language Impairment	*NA*	*NA*	*68 (Itinerant)*
Traumatic Brain Injury	*May be placed in any program, according to the IEP.*		
Combined group of students needing Level I services with students needing Level II services	*20 Points (see values for students receiving Level I services when combined with students receiving Level II services)*		

Values for students receiving Level I services when combined with students receiving Level II services

Disability Category	*Level II Values*		*Level I*
	With Paraprofessional 100% of the time	*Without Paraprofessional 100% of the time*	*Values*
Autism	*2.5*	*3.3*	*1*
Deaf-blindness	*2.5*	*3.3*	*1*
Developmental Delay: age 5-6	*2.0*	*2.5*	*1*
Emotional Disability	*2.0*	*2.5*	*1*
Hearing Impairment/Deaf	*2.0*	*2.5*	*1*
Learning Disability	*2.0*	*2.5*	*1*
Intellectual Disability	*2.0*	*2.5*	*1*
Multiple Disabilities	*2.5*	*3.3*	*1*
Orthopedic Impairment	*2.0*	*2.5*	*1*
Other Health Impairment	*2.0*	*2.5*	*1*
Traumatic Brain Injury	*2.0*	*2.5*	*1*

Gifted Education: *Local school boards shall employ one licensed, full-time equivalent position per 1,000 students in grades kindergarten through 12 for gifted education services.*

Career and Technical Education: *Each local school board shall employ licensed, full-time equivalent positions in career and technical education necessary to comply with the following requirements:*

a. *Career and technical education laboratory classes that use equipment that has been identified by the U.S. Department of Labor for hazardous occupations shall be limited to a maximum of 20 students per laboratory.*

b. *Career and technical education courses approved for students who are disadvantaged shall be limited to an average of 15 students per instructor per class period with no class being more than 18.*

c. *Career and technical education courses approved for students with disabilities shall be limited to an average of 10 students per instructor per class period with no class being more than 12 or up to an average of 12 students per class period with no class being more than 15 where an instructional aide is provided.*

d. *Enrollments in career and technical education courses shall not exceed the number of individual work stations.*

e. *Career and technical education programs using the cooperative education method of instruction shall be limited to an average of 20 students per instructor per class period with no class being more than 24 where the cooperative education method of instruction is required and have a class period assigned to the instructor for on-the-job coordination for each 20 students participating in on-the-job training.*

Provide school divisions the flexibility to deploy assistant principals to the schools with the greatest needs, so long as they employ a sufficient number of assistant principals divisionwide to meet the total number required in the current SOQ staffing requirement.

School divisions that employ a sufficient number of assistant principals to meet these staffing requirements may assign assistant principals to schools within the division according to the area of greatest need, regardless of whether such schools are elementary, middle, or secondary.

Define the categories of personnel who make up "support services," specify how those positions are funded, and require transparency in the use of funds by mandating divisions publicly report the state and local amounts budgeted and expended for each category.

For the purposes of this title, unless the context otherwise requires, "support services *positions*" shall include ~~*services provided by the school board members; the superintendent; assistant superintendents; student services (including guidance counselors, social workers, and homebound, improvement, principal's office, and library-media positions); attendance and health positions; administrative, technical, and clerical positions; operation and maintenance positions; educational technology positions; school nurses; and pupil transportation positions.*~~ *the following:*

1. *Executive policy and leadership positions, including school board members, superintendent, and assistant superintendents;*

2. *Fiscal and human resource positions, including fiscal and audit operations, human resources, and procurement;*

3. *Student support positions, which include:*

    a. *Social workers and social work administrative positions;*

    b. *Guidance administrative positions not included in paragraph H.4, ,*

    c. *Homebound administrative positions supporting instruction;*

    d. *Attendance support positions related to truancy and drop-out prevention;*

    e. *Health and behavioral positions, including school nurses and school psychologists;*

4. *Instructional personnel support, including professional development positions and library and media positions not included in H.3;*

5. *Technology professional positions not included in paragraph J;*

6. *Operation and maintenance positions, including facilities; pupil transportation positions; operation, and maintenance professional and service positions; security services, trades, and laborer positions;*

7. *Technical and clerical positions, including fiscal and human resource technical/clerical, student support technical/clerical, instructional personnel support technical/clerical, operation and maintenance technical/clerical, administration technical/clerical, and technology technical/clerical positions;*

8. *School-based clerical personnel in elementary schools, part-time to 299 students, one full-time at 300 students; clerical personnel in middle schools, one full-time and one additional full-time for each 600 students beyond 200 students and one full-time for the library at 750 students; clerical personnel in high schools, one full-time and one additional full-time for each 600 students beyond 200 students and one full-time for the library at 750 students.*

Pursuant to the appropriation act, support services shall be funded from basic school aid on the basis of prevailing statewide costs *unless the Standards of Quality specify a staffing standard.*

Permit school divisions to use funds for support services to provide additional instructional services and include instructional services as a separate category to be reported publicly.

School divisions may use the state and local funds for support services to provide additional instructional services.

Local school divisions shall report publicly the state and local amounts budgeted and expended for each category of support services listed above. Local school divisions shall also report publicly the amounts they received for support services that were used to provide additional instructional services.

VIRGINIA BOARD OF EDUCATION

Report

VIRGINIA BOARD OF EDUCATION: REVIEW OF THE CURRENT STANDARDS OF QUALITY

PRESENTED TO

THE HONORABLE TIMOTHY M. KAINE
GOVERNOR OF VIRGINIA
AND
THE VIRGINIA GENERAL ASSEMBLY

October 2009

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Executive Summary

In response to a directive from the 2009 General Assembly, the Virginia Board of Education undertook a comprehensive review of the Standards of Quality (SOQ). In this directive, the Board was asked to "evaluate the appropriateness of the existing staffing standards for instructional positions and the appropriateness of establishing ratio standards for support positions, with the objective of maximizing resources devoted to the instructional program."

This review was undertaken during the April through October time frame. During that time, the following action was taken by the Board:

- Two public comment periods were created:
    1. One in the spring and summer to gather comment for Board consideration and;
    2. One in the fall to solicit additional comment and feedback on SOQ options under Board consideration.

- A consultant was procured to:
    1. Examine SOQ allotted positions in relation to actual school division staffing;
    2. Investigate other states' education funding formulas in comparison to Virginia;
    3. Analyze school division efficiency reviews in relationship to the SOQ; and
    4. Undertake research and a literature review regarding appropriate ratios for both instructional and support positions.

With the information gathered during the first public comment period and with information from the consultant, the Board, in September of 2009, formulated a series of policy directions as well as issues for further study in the following areas:

Policy Directions

- Enhance the Standards of Quality so that the Commonwealth's basic foundation program for K-12 public education reflects a comprehensive educational program of the highest quality.
- Provide clarity and greater transparency in SOQ funding with the goal of maintaining the Commonwealth's commitment to public education funding at the state and local levels and encouraging a continued emphasis on school-based instructional services.
- Provide greater flexibility to school divisions in using noninstructional personnel funding for instructional support services.

- Support the appropriateness of establishing ratio standards for individual categories of "support service" positions as is the current practice used for instructional personnel.
- Advocate against permanent structural changes to the Standards of Quality that result in decreased funding for K-12 public education.
- Begin building a more comprehensive basic foundation program by including in the SOQ gifted, special education, and career and technical staffing ratios and certain incentive programs that have become core components of K-12 educational programs statewide and currently funded in the appropriations act.
- Set priorities for the Board's unfunded SOQ recommendations from previous years so that these instructional staffing standards can be fully implemented in future years.
- Begin to address the Board's school leadership priorities of requiring a principal in every school and increasing the number of assistant principals in schools with the greatest need.
- Mitigate the perverse incentive of reducing a school division's special education funding when it mainstreams students with disabilities into general education classrooms or uses Response to Intervention (RtI) and/or other instructional supports to reduce the number of students identified as needing special education services.
- Provide additional policy guidance and direction to school divisions offering alternative or nontraditional educational programs, such as the Individual Student Alternative Education Plan (ISAEP).

SOQ Language Revisions to Address Policy Directions

- Codify the Board of Education's recommendations that were included in the 2009 Appropriation Act providing flexibility in the use of existing funds for hiring reading specialists, mathematics specialists, data coordinators, and instruction of English language learners.
- Codify the provisions of the Early Intervention Reading Initiative and the Algebra Readiness program by including them in the Standards of Quality and requiring all school divisions to provide these interventions with funding currently appropriated for these incentive programs.
- Codify the appropriation act provision that the Standards of Quality includes a minimum of 58 licensed, full-time instructional positions per 1,000 students, including instructional positions for special education, gifted education, and career and technical education.
- Codify the staffing standards for special education (currently in regulations), gifted education (currently in the Appropriation Act), and career and technical education (currently in regulations).

- Provide school divisions the flexibility to deploy assistant principals to the schools with the greatest needs, so long as they employ a sufficient number of assistant principals divisionwide to meet the total number required in the current SOQ staffing requirement.
- Define the categories of personnel who make up "support services," specify how those positions are funded, and require transparency in the use of funds by mandating divisions publicly report the state and local amounts budgeted and expended for each category.
- Permit school divisions to use funds for support services to provide additional instructional services and include instructional services as a separate category to be reported publicly.

Issues for Further Study

As resources become available, conduct a comprehensive study of the following complex funding issues and report the findings to the Governor and General Assembly for consideration as part of the 2010 review of the SOQ.

- The feasibility of converting the prevailing costs for each major category of the "support services" positions into ratios (for example, based on positions per 1,000 students), and including ratios for some or all of the categories in the appropriation act.
- The feasibility of establishing alternative staffing approaches to provide school divisions with additional instructional resources to address identified needs. This could include ratios based on positions per 1,000 students for assistant principals, school counselors, and library-media specialists that would reduce funding "cliffs." It could also include assigning weights for students who may be at-risk and require additional support, including special education services, services to English language learners, and services to disadvantaged students.
- The feasibility of creating a special education incentive fund or other funding methodologies to mitigate the perverse incentive of reducing a school division's special education funding when it mainstreams students with disabilities into general education classrooms or uses Response to Intervention (RtI) and/or other instructional supports to reduce the number of students identified as needing special education services.
- The feasibility of updating technology staffing ratios, taking into consideration the increased role of technology in instruction, assessment, and operations since staffing standards were first established in the SOQ.
- The feasibility of updating career and technical education staffing ratios, taking into consideration the (i.) implementation of new curricular pathways that require high-tech equipment and specialized instruction and (ii.) anticipated increased enrollments in CTE courses given the newly created standard technical and advanced technical diplomas.

Authority for the Report

The 2009 General Assembly added language to Item 140 of the Appropriation Act requiring the Board of Education to review the Standards of Quality (SOQ) and submit a report by November 1, 2009. Specifically, Item 140.C.5.d.3) states:

> *The Board of Education shall review the current Standards of Quality to evaluate the appropriateness of the existing staffing standards for instructional positions and the appropriateness of establishing ratio standards for support positions, with the objective of maximizing resources devoted to the instructional program. The findings of this review, its associated costs, and its final recommendations for rebenchmarking shall be submitted to the Governor, the Chairmen of House Appropriations and Senate Finance Committees and the Joint Subcommittee on Elementary and Secondary Education Funding established pursuant to Item 1, paragraph H. of this Act no later than November 1, 2009.*

The study group was made up of the Virginia Board of Education's Standing Committee of the Standards of Quality, a committee of the whole:

Mrs. Eleanor Saslaw, Chair, SOQ Committee
Dr. Mark Emblidge, President, Virginia Board of Education
Dr. Ella Ward, Vice-President, Virginia Board of Education
Dr. Thomas Brewster
Mrs. Isis Castro
Mr. David Johnson
Mr. K. Rob Krupicka
Dr. Virginia McLaughlin
Mr. Kelvin Moore

Background

Article VIII, § 2 of the *Constitution of Virginia* requires the Board of Education to determine and prescribe standards of quality for the public schools in Virginia. The *Constitution* states:

> *Standards of quality for the several school divisions shall be determined and prescribed from time to time by the Board of Education, subject to revision only by the General Assembly. The General Assembly shall determine the manner in which funds are to be provided for the cost of maintaining an educational program meeting the prescribed standards of quality….*

On August 7, 1971, the Board of Education adopted the first Standards of Quality. They were revised by the General Assembly in 1972 and adopted as uncodified Acts of Assembly. In 1974, they were revised into eight standards. In 1984, they were codified by the General Assembly, and in 1988 they were arranged into their current format. Significant modifications have been made by the General Assembly since then.

The Board of Education revised its bylaws in October 2001 to require the Board to "determine the need for a review of the SOQ from time to time but no less than once every two years." In 2002, the General Assembly passed several bills regarding the Standards of Quality. Senate Bill 201 added § 22.1-18.01 to the *Code* and required that "To ensure the integrity of the standards of quality, the Board of Education shall, in odd-numbered years, exercise its constitutional authority to determine and prescribe the standards, subject only to revision by the General Assembly, by (i) reviewing the standards and (ii) either proposing amendments to the standards or (iii) making a determination that no changes are necessary." (The review was later changed to even-numbered years by the 2006 General Assembly.) House Bill 884 and Senate Bill 350 amended § 22.1-18 of the *Code* and required that the Board include in its annual report to the General Assembly, "a complete listing of the current standards of quality for the Commonwealth's public schools, together with a justification for each particular standard, how long each such standard has been in current form, and whether the Board recommends any change or addition to the standards of quality." Senate Joint Resolution 120 requests that the Board of Education "revise the Standards of Quality to ensure these statutory practices are realistic vis-à-vis the Commonwealth's current educational needs and practices."

The Standing Committee of the Standards of Quality was created by resolution of the Board of Education in November of 2001 and held its first meeting in January of 2002. The stated purpose of the committee was to determine the information to be reviewed to determine the condition and needs of public education and the process to be used to complete this comprehensive review. The committee created an inclusive public process, encouraged public comment from all education constituents and the public, and

considered policy issues brought before it by superintendents, principals, teachers, local school board members, parents, and county and municipal officials.

As a result of this review, the Board of Education made the following recommendations to revise Standard Two of the Standards of Quality.

Standard Two – Instructional, administrative, and support personnel.

2003 Board Recommendations:

- Require one full-time principal in each elementary school. [The SOQ currently requires a half-time principal for elementary schools with fewer than 300 students.]
- Require one full-time assistant principal for each 400 students in each school. [The SOQ currently requires one half-time assistant principal at an elementary school with between 600 and 899 students and one full-time assistant principal at an elementary school with 900 or more students. The current middle and secondary assistant principal standard in the SOQ is for one full-time assistant principal per 600 students in a school.]
- Fund elementary resource teachers in art, music, and physical education. The proposal would provide three periods per week for art, music, and physical education for students in grades K-5, assuming a 24:1 pupil-teacher ratio. This proposal translates into five instructional positions for every 1,000 students.
- Reduce the secondary school pupil to teacher funding ratio from 25:1 to 21:1 to support scheduled planning time for secondary teachers.
- Reduce the state required speech language pathologist caseload from 68 to 60 students.
- Fund two technology positions at one specialist per 1,000 students in grades K-12 divisionwide, one to provide technology support, and one to serve as a resource teacher for instructional technology.
- Require one full-time instructional position for each 1,000 students to serve as a reading specialist.
- Revise the funding formula for the SOQ prevention, intervention, and remediation program.

The following recommended changes were enacted by the 2004 General Assembly in House Bill 1014 and Senate Bill 479:

- Required local school boards to employ five positions per 1,000 students in grades kindergarten through five to serve as elementary resource teachers in art, music, and physical education. (Effective July 1, 2005.)
- Required local school boards to assign instructional personnel in a manner that produced schoolwide ratios of students in average daily memberships to full-time equivalent teaching positions of 21 to one in middle schools and high schools. School divisions were required to provide all middle and high school teachers

with one planning period per day or the equivalent, unencumbered of any teaching or supervisory duties. (Effective July 1, 2005.)

- Required local school boards to employ two positions per 1,000 students in grades kindergarten through 12, one to provide technology support and one to serve as an instructional technology resource teacher. (Effective July 1, 2005.)
- Established a funding formula for the prevention, intervention, and remediation program proposed by the Board. (Effective July 1, 2004.)

While the General Assembly passed the legislation recommended by the Board, it did not recommend funding for four of the Board's proposals. These included one full-time principal in each elementary school; one full-time assistant principal for each 400 students in each school; reduction of the state-required speech language pathologist caseload from 68 to 60 students; and one full-time reading specialist for each 1,000 students.

The 2004 Appropriation Act passed by the General Assembly changed the required number of full-time equivalent instructional positions for each 1,000 students identified as having limited English proficiency from 10 to 17, but no changes were made in the SOQ to reflect this language.

In 2004, the Board recommended that the language in the SOQ be changed to comport with the Appropriation Act requirement. Specifically, the Board recommended that "state funding, pursuant to the appropriation act, shall be provided to support 17 full-time equivalent instructional positions for each 1,000 students identified as having limited English proficiency." This change was enacted by the 2005 General Assembly through House Bill 1762 and Senate Bill 779. The bills also clarified provisions regarding the five positions per 1,000 students in kindergarten through grade five who serve as elementary resource teachers in art, music, and physical education and the two positions per 1,000 students in grades kindergarten through 12, one to provide technology support and one to serve as an instructional technology resource teacher to be full-time equivalent positions. However, the 2005 General Assembly did not appropriate funding for the four remaining Board recommendations that had been proposed.

In 2006, the Board began considering further changes to the Standards of Quality. It again reviewed the Standards of Quality through an inclusive public process, encouraged public comment from all education constituents and the public, and considered policy issues brought before it by superintendents, principals, teachers, local school board members, parents, and county and municipal officials.

Following this review, the Board made the following staffing recommendations:

- Require one full-time principal in each elementary school. [The SOQ currently requires a half-time principal for elementary schools with fewer than 300 students.]
- Require one full-time assistant principal for each 600 students in each school. [The SOQ currently requires one half-time assistant principal at an elementary

school with between 600 and 899 students and one full-time assistant principal at an elementary school with 900 or more students. The current middle and secondary assistant principal standard in the SOQ is for one full-time assistant principal per 600 students in a school.]

- Require one full-time equivalent instructional position for each 1,000 students in average daily membership to serve as reading specialists for the school division.
- Require school boards to employ enough speech-language pathologists to ensure a caseload that does not exceed 60 students per position.
- Require one full-time equivalent instructional position for each 1,000 students in grades kindergarten through eight to serve as a mathematics specialist.
- Require one full-time equivalent position per 1,000 students in grades kindergarten through 12 to provide schools with support in data management and utilization and the administration of state assessments. The data manager or test coordinator would hold a license issued by the Board of Education and serve as a resource to principals and classroom teachers in analyzing and interpreting data for instructional purposes.
- Require instructional and paraprofessional staff to ensure the following case load maximums for students who are blind or vision impaired: (i) resource teachers who serve such children for less than 50 percent of the instructional day, 24 students to one; (ii) teachers of self contained classes serving such children for 50 percent or more of the instructional day with a paraprofessional, 10 students to one; or (iii) teachers of self contained classes serving such children for 50 percent or more of the instructional day without a paraprofessional, eight to one.

While the 2007 General Assembly passed Senate Bill 795 providing for some technical and policy changes to the SOQ, it did not pass any of the recommended staffing changes to Standard Two.

On November 29, 2007, the Board of Education adopted a resolution reaffirming the commitment to the seven staffing recommendations that had not yet been funded and urging the Governor and General Assembly to renew their consideration of these recommendations.

In November of 2008, the Board again reaffirmed its commitment to the seven unfunded recommendations and also offered alternative options to address three of these recommendations as well as an additional option related to English Language Learners (ELLs). These alternatives were offered with an understanding of fiscal constraints and the need to promote flexibility without expending additional resources. The options offered were intended to integrate and link existing programs that reside both within the SOQ and outside of it and were as follows:

Recommendation 1 - Testing Coordinator/Data Manager. This addressed the need for a testing coordinator/data manager for every 1,000 students. The position would be Board-licensed and would be responsible for analyzing and interpreting data for the improvement of instruction. The SOQ already provides for one instructional technology resource teacher (ITRT) per 1,000 students. This

option was intended to give school divisions a choice to employ the ITRT, the testing coordinator/data manager, or a position that blends both duties. *This recommendation was accepted by the 2009 General Assembly and included in the Appropriation Act, effective July 1, 2009.*

Recommendation 2 - Reading Specialist. This option relates to the recommendation for one reading specialist for every 1,000 students in all grades. The option permits school divisions to hire a Board-licensed position to provide the intervention required for the Early Intervention Reading Initiative (EIRI), a program funded outside of the SOQ. School divisions could hire a reading specialist within the scope of the EIRI program. The use of the specialist to provide remedial services allows for efficiency and flexibility for school divisions delivering services to the K-3 population and was intended to integrate the EIRI with the SOQ. *This recommendation was accepted by the 2009 General Assembly and included in the Appropriation Act, effective July 1, 2009.*

Recommendation 3 - Mathematics Specialist. This option relates to the recommendation for one mathematics specialist for every 1,000 students in grades K-8, an option similar to that of the reading specialist. This option links the Algebra Readiness Intervention (ARI) to the SOQ by permitting school divisions to hire mathematics specialists as another option to provide the required intervention within the scope of the ARI program, which serves grades six to eight. The ARI resides outside of the SOQ. *This recommendation was accepted by the 2009 General Assembly and included in the Appropriation Act, effective July 1, 2009.*

Recommendation 4 - Instruction to English Language Learners (ELLs). To supplement the services provided to students identified with Limited English Proficiency (LEP), school divisions could use funds from the SOQ Prevention, Intervention, and Remediation account to hire additional ELL teachers to provide instruction. This funding would supplement the instructional services provided by the current SOQ staffing standard of 17 per 1,000 LEP students. *This recommendation was accepted by the 2009 General Assembly and included in the Appropriation Act, effective July 1, 2009.*

Study Methodology and Implementation

The 2009 General Assembly added language to Item 140 of the Appropriation Act requiring the Board of Education to review the SOQ "to evaluate the appropriateness of the existing staffing standards for instructional positions and the appropriateness of establishing ratio standards for support positions, with the objective of maximizing resources devoted to the instructional program."

In response to the mandate the Virginia Board of Education, on April 30, 2009, adopted the following resolution establishing the plan for conducting the mandated review of the SOQ.

ESTABLISHING A PLAN TO CONDUCT
THE 2009 REVIEW OF THE STANDARDS OF QUALITY

WHEREAS, Article VIII, Section 2, *Constitution of Virginia*, states in part, *"Standards of quality for the several school divisions shall be determined and prescribed from time to time by the Board of Education, subject to revision only by the General Assembly."*

WHEREAS, the General Assembly has directed the Board of Education to "*…review the current Standards of Quality to evaluate the appropriateness of the existing staffing standards for instructional positions and the appropriateness of establishing ratio standards for support positions, with the objective of maximizing resources devoted to the instructional program….*"

WHEREAS, the Standards of Quality prescribe broad policies to ensure that each public school in the Commonwealth is a school of quality and that each child in the Commonwealth has access to a school that will offer a quality education;

WHEREAS, the Board of Education believes that public education is of the highest priority in the state budget, and that the SOQ is the foundation program for public education in the Commonwealth; and

WHEREAS, the Standards of Quality define the minimum foundation the Commonwealth must provide to meet its constitutional obligation to maintain "an educational program of high quality" for the children of Virginia;

NOW, THEREFORE, BE IT RESOLVED that the Board of Education plans to conduct the 2009 review of the Standards of Quality as follows:

April 29 and 30, 2009

Standards of Quality Committee meeting and Board of Education meeting:

- Review background information and the charge from the General Assembly.
- Approve the work plan.
- First public comment period May 1 through July 31.

May 27, 2009

Standards of Quality Committee meeting:

- Invite specified stakeholders to give their recommendations.
- Invite the public to give their recommendations.

- Department of Education staff or the consultant will report on the research and data collection efforts.

June 24, 2009

Standards of Quality Committee meeting:
- Invite specified stakeholders to give their recommendations.
- Invite the public to give their recommendations.
- Department of Education staff or the consultant will report on the research and data collection efforts.

July 22, 2009

Standards of Quality Committee meeting:
- Invite the public to give their recommendations.
- Department of Education staff or the consultant will report on the research and data collection efforts.

September 17, 2009

Board of Education meeting**:**
- Review proposed recommendations, including statutory language and the fiscal impact.
- Second public comment period September 14 through October 2.

October 22, 2009

Board of Education meeting:
- Approve the recommendations.
- Submit the proposal to the Governor and the General Assembly.

The first public comment period was set for May 1 through July 31, 2009, to receive comments at the three public hearings during the SOQ committee meetings, at regularly scheduled Board of Education meetings and via mail and electronic mail. A second public comment period was set for September 14, 2009 through October 2, 2009, with four public hearings held on September 30, 2009, in Richmond, Pulaski, Chesapeake and Fairfax. Additionally, comments were also received at regularly scheduled Board of Education meetings and via mail and electronic mail during this period.

In order to keep the public informed about the review process, Department of Education staff created a Web page to provide information to the public about the SOQ review process and an e-mail mailbox for public comment (SOQComments@doe.virginia.gov). A summary of comments received during the public hearings at the SOQ Committee meetings along with the minutes of those meetings were posted on the Web site. Department of Education staff also sent a survey to all school divisions to gather information on possible changes needed to Standard Two of the SOQ. The Department

also contracted with a consultant to conduct research and analyze data collected from all Virginia school divisions in their Annual School Report submission to the Department for the 2007-2008 school year. More information on the consultant work is addressed later in this report and in Appendix B to this report.

Summary of Comments

Two public comment periods were held regarding the Standards of Quality (SOQ). The first was held from May 1, 2009 through July 31, 2009 and solicited general comments on the SOQ as it is presently written. The Board of Education received comments in its SOQ Committee meetings, Board of Education meetings and through the mail.

May 2009 SOQ Meeting

The following groups were invited and provided comments regarding revisions to the Standards of Quality at the May 27, 2009 SOQ Committee meeting:

- Virginia Association of School Superintendents;
- Virginia School Boards Association;
- Virginia Education Association;
- Virginia Association of Elementary School Principals;
- Virginia Association of Secondary School Principals;
- Virginia Association of Supervision and Curriculum Development;
- Virginia Parents Teachers Association;
- Virginia Municipal League; and
- Virginia Association of Counties.

In addition, the SOQ Committee welcomed comments from the public. In response, the Virginia First-Cities Coalition provided comments.

June 2009 SOQ Meeting

Four organizations provided comments at the June 24, 2009 SOQ committee meeting:

- Virginia Council of Administrators of Special Education;
- Virginia Association of School Nurses;
- Virginia School Counselor Association; and
- Virginia Consortium of Gifted Education Administrators.

Six public comments were also received at the meeting, including representatives from the Virginia Friends of Mali, JustChildren, the Virginia Parent Teacher Association, and the Petersburg Advocates for Children.

July 2009 SOQ Meeting

The public was invited to provide comments regarding revisions to the Standards of Quality at the July 22, 2009 SOQ committee meeting. Six speakers provided comments, including representatives from JustChildren, FACES of Virginia: Foster, Adoption, and Kingship Association, Fairfax County Public Schools, and Parent Leaders Advocating for Children's Education (P.L.A.C.E.), and Richmond City Schools.

In total, 31 comments were received during the Standards of Quality Committee meetings. Additionally, five comments were received during Board of Education meetings.

Additional Public Comment

During the first public comment period, written comments were also received from school divisions, organizations and individuals. Four comments were received from local school divisions, five comments were received from organizations and five comments were received from individuals. In addition, 1,130 individuals signed a petition supporting the recommendations of JustChildren.

Commenters made the following major recommendations to the Board:

- Oppose the proposal to adopt a cap on the number of support positions.
- Continue to recommend the staffing standards that have been proposed by the Board, but have not been funded by the General Assembly.
- Oppose lowering the Standards of Quality in any way.
- Prioritize mandates placed on local school divisions.
- Ensure that school division efforts to provide students with disabilities access to the general education curriculum are not hindered by funding incentives based on placement.
- Include caseload size for teachers of the vision impaired.

Commenters also made recommendations regarding staffing to the Board. These comments included:

- Require a full-time principal in for every school, employed on a 12 month basis.
- Increase the elementary school assistant principal staffing ratio from 900 students to one principal to 400 students to one principal.
- Do not supplant an assistant principal position by specifying that one assistant principal in each school function as a data coordinator.
- Require one Registered Nurse (RN) or Licensed Practical Nurse (LPN) in each school.
- Set the following staffing ratio for nurses in all schools: at least one half-time registered nurse to 299 students; at least one full-time registered nurse at 300

students; at least one half-time registered nurse for each additional 500 students over 1,000.

- Require a full time reading specialist in each school.
- Require additional reading services in certain schools based on a weighted formula.
- Continue to maintain a required school counselor/student ratio in the SOQ.
- Require local school divisions to employ two additional full-time equivalent positions in gifted education, one to plan, implement and evaluate gifted education and the other to act as a resource teacher in grades K-12 at a ratio of one teacher to 1,000 students.
- Increase state funding for English as a Second Language (ESL) teachers from 17 teachers per 1,000 students to 30 teachers per 1,000 students.
- Include one data coordinator for each school.
- Include at least one psychologist for up to 2,000 students.

A second public comment period was held from September 15 through October 2, 2009. The Board of Education adopted the following proposals at its meeting on September 17, 2009: 1) Policy Directions and Options; 2) Possible Action Items and Issues for Further Action; and 3) Draft Proposed Revisions to the Standards of Quality (see Board Findings section of this report). During this second public comment period, the public was invited to provide recommendations on these proposals. A total of 187 written comments were received from individuals, seven written comments were received from local school divisions and 12 written comments were received from organizations. Additionally, 92 comments were received during four public hearings.

Commenters made the following major recommendations to the Board:

- Full funding of the SOQ is essential.
- Revise the SOQ to include a minimum of one hour of planning time each day for all primary and elementary classroom teachers.
- Oppose the proposal to adopt a cap on the number of support positions.
- Support staff personnel, such as counselors, attendance workers, nurses, custodians, social workers, psychologists, and technology staff are essential to student education and welfare.
- Continue to recommend the staffing standards that have been proposed by the Board, but have not been funded by the General Assembly.
- Support of the Board's proposal to allow school divisions to have flexibility in hiring specialists in reading, mathematics, and ESL, and deploying assistant principals to schools with the greatest need, and in using funds for support services to provide additional instructional services.
- Support codifying some of the staffing ratios that are funded in the Appropriation Act.
- Support the policy directions proposed by the Board as well as the proposed language changes to the SOQ.

Commenters also made recommendations regarding staffing to the Board. These comments included:

- Include reading specialists at a ratio of one specialist to 1,000 students.
- Include a ratio of one nurse for every 750 students.
- Do not reduce or eliminate school counseling positions.
- Require local school divisions to employ two additional full-time equivalent positions in gifted education, one to plan, implement and evaluate gifted education and the other to act as a resource teacher in grades K-12 at a ratio of one teacher to 1,000 students.
- Increase the staffing ratio for English language learners to 30 teachers to every 1,000 students.
- Consider funding the required annual assessment of English language proficiency.
- Include a ratio of one psychologist for every 2,000 students.
- Do not cut positions in school libraries, including clerical personnel.
- Include elementary school library assistant positions.
- Oppose the proposal that would permit school divisions to use state and local funds for instructional technology resource teachers to employ a data coordinator position, an instructional technology resource teacher, or a data coordinator/instructional technology resource teacher blended position.
- Any changes to staff ratios and other regulations for career and technical education should not only reflect the needs of the schools, but also the needs of industry.
- Lower the caseload for speech language pathologists from 68 students to 60 students.
- Require at a minimum that all elementary schools have one full-time licensed art teacher, one full-time licensed music teacher, and one full-time licensed physical education teacher.

Commenters made specific recommendations regarding the policy directives and draft changes to the SOQ. The following are representative of their comments:

- Some comments supported the draft policy directives, while others supported all but the proposal to provide flexibility to use local and state funds for instructional technology resource teachers to employ a data coordinator position, an instructional technology resource teacher position, or a data coordinator/instructional technology resource position.
- Some comments supported all of the draft changes to the SOQ, while others supported all but the early reading intervention and mathematics intervention initiatives because these initiatives would result in increased testing, increased reporting requirements and do not recognize other local assessment options that may be proven effective. Also, the initiatives would result in redirecting staff to non-instructional purposes.
- There was disagreement among the commenters on increased staffing for gifted education, the employment of licensed personnel using Algebra Readiness funds, and the provisions regarding reading specialists.

A summary of all of the comments may be found in Appendix E of this report.

APA Report and Recommendations

Background

This report, *A Review and Analysis of the Virginia Standards of Quality*, was prepared by Augenblick, Palaich and Associates Inc. (APA), an education consulting firm based in Denver, Colorado. Much of APA's work has been for state-level policy makers in areas in school finance developing state aid allocation systems, evaluating school finance formulas, providing technical assistance on education funding-related issues, and assisting with state aid formulas in other states.

APA reviewed personnel ratios used in other states by contacting state officials, reviewed relevant literature and efficiency reports for school divisions in Virginia, and analyzed data provided by the Virginia Department of Education about the numbers of staff allocated by SOQ staffing standards or prevailing costs and the numbers of personnel actually employed, in order to understand what relationships might exist. The number of personnel actually employed was derived from data reported by school divisions to the Virginia Department of Education in the Annual School Report.

APA noted that, like almost every other state, Virginia's school finance system uses a foundation program as the primary basis of allocating state aid with the funding target level set by the SOQ for Virginia. School divisions can supplement this funding with local revenues. APA cited that many other states use foundation programs although most determine revenue targets on the basis of a dollar amount per student with adjustments for student and division characteristics.

APA also noted that the use of personnel ratios as part of a school finance system serves several purposes, including:

1. Creating a direct linkage between state requirements and division funding;
2. Increasing the likelihood that school divisions can meet state expectations if staffing allocations are tied to what is needed to meet objectives, assuming that there is a close relationship between ratios and actual staffing needs;
3. Increasing equity among divisions in the services offered; and
4. Requiring divisions to employ certain personnel as an assurance that all divisions will do so.

The APA report also discussed weaknesses regarding the use of personnel ratios, which include:

1. Not taking into account different personnel needed to serve divisions with different characteristics or special circumstances;
2. The undermining of local responsibility to organize education services by specifying how services should be delivered, when a state holds school divisions accountable for student performance as most states do; and
3. The issue of whether local governing bodies may appropriate local funding to school divisions to employ additional personnel and whether there is resource equity across school divisions.

Research/Literature Review

APA reviewed all of Virginia's division level efficiency studies conducted in the past few years, and found little information in these studies that would suggest needed changes in the current SOQ ratios. APA also compared Virginia's funding model to funding formulas in Alabama, Delaware, North Carolina, and Tennessee. All of these states provide staffing allocations for principals, assistant principals, and classroom teachers, but not all states have staffing allocations for all positions. Moreover, staffing ratios vary widely from state to state.

APA reviewed existing literature for ratio recommendations for the following positions:

1. Classroom teachers;
2. English as a Second Language (ESL) and special education teachers;
3. School administrators;
4. Clerical staff;
5. Instructional aides;
6. Library staff;
7. Nurses;
8. Technology specialists; and
9. Counselors.

APA cited that the literature about classroom teachers recommends small K-3 class sizes, but there is limited research about the benefits of small class sizes in the secondary level. The firm also noted that there is little research on instructional aides and what exists is contradictory and there is little research about school administrators, clerical, custodians or maintenance worker ratios. Finally, APA also found that technology specialists and counselors are noted as important in the literature, but there are no recommended ratios.

In examining personnel ratios in Virginia, APA's intent was to understand the relationship between the numbers of SOQ personnel allotted to each school division and division characteristics, particularly regarding enrollment and student need. APA also examined the relationship between the actual number of personnel employed and the number allotted for the SOQ and what, if any, differences might exist between the SOQ allotment and the number of positions actually employed. To do this, APA used weights to estimate student need. The full report and its accompanying tables (see Appendix B) explain the weighting in greater detail.

Findings

In its work, APA highlighted some key points about the SOQ for the Board's consideration. First, it appears that school divisions employ more personnel than the SOQ ratios provide. (The Annual School Report captures all positions employed within school divisions not just those related to the SOQ, and APA indicated that the finding is not unexpected for this reason.) Second, most of personnel categories with larger numbers of personnel actually employed fall into the instructional categories. APA found that the numbers of elementary and secondary teachers appear to be related to division needs. Furthermore, it was found that school divisions appear to be using the support costs received as part of the SOQ funding model to employ more

instructional personnel, validating APA's finding that the SOQ is intended to be a minimum education foundation program.

APA also found that all SOQ ratios could be expressed in personnel per 1,000 student terms, assuming that such a shift does not detrimentally affect funding or staffing and class sizes at the school and classroom levels. According to APA, this would simplify the funding methodology and avoid the "cliffs" built into some current SOQ ratios (based on break points related to school size) which create more variation in school division staffing.

Explanation of Statistics Calculated in the Report

APA provided some basic statewide information regarding the types of personnel analyzed in the report. In comparing actual staffing for instructional positions and the SOQ, APA found that:

- In ten of the 14 types of instructional personnel analyzed, the average number of personnel actually employed is at least ten percent higher than the average number of personnel allotted by the SOQ model.
- In nine of the 14 types of instructional personnel, there is a higher level of variation in the number of personnel per 1,000 students allotted by the SOQ model and the correlation between SOQ allocation and division size and student need is weak.

In comparing actual staffing for support positions and the SOQ:

- In four of the nine support personnel categories, the average number of personnel actually employed is at least ten percent lower than the number of personnel allotted by the SOQ model.
- The numbers of all types of support staff allotted under the SOQ ratios are very similar across school divisions. There appears to be no relationship between SOQ allocation and need although there is a weak relationship between actual and student need.

APA also examined the relationship between staffing and division size and student need across groups of school divisions. In analyzing the relationship between staffing and division size, it found that:

- The number of elementary and secondary teachers and secondary aides allotted by the SOQ model is sensitive to division enrollment.
- The number of support staff is unrelated to division size when looking at the SOQ allocations.

In analyzing the relationship between staffing and student need, it found that:

- There is a small relationship between SOQ allotted elementary and secondary teachers and division needs.
- The relationship is stronger for actual teachers employed. This suggests that school division actual staffing is more sensitive to need than the SOQ appears to be.

The full report from the consultants is contained in Appendix B of this report. Detailed information on these findings may be found in the section of the APA report labeled "*Examining Personnel Ratios in Virginia School Divisions*" and in Tables 2A, 2B, 3, and 4 of this report.

Survey of Local School Divisions and Recommendations

Background

In mid July, a Superintendent's Memorandum was distributed asking school divisions to respond to a survey that would be used for the study of the Standards of Quality (SOQ). The intent of the survey was to gather information from school divisions that would help the Board look at the SOQ as a whole and determine how school division needs and concerns could be factored in any recommended changes to the standards. The survey had a short turnaround time and was designed with the intent to gather data in the least burdensome manner possible, recognizing the time constraints on school divisions and the short turnaround time for reporting to the General Assembly. Eighty-five school divisions responded to the survey, for a general response rate of 64 percent.

The survey was divided into three parts:

1. Standards of Quality questions;
2. Flexibility language; and
3. General Assembly reporting requirements.

The survey asked for answers to Yes and No and general ranking questions in addition to soliciting narrative feedback regarding school division recommendations for SOQ changes and additional information on school division challenges.

The information below summarizes the responses from school divisions to the Yes/No and ranking questions. Because the narrative information collected from the responding school divisions is voluminous, the report summarizes the major themes and commonalities observed in the narratives provided.

Part I: SOQ Questions

1. Should there be specific staffing standards for some or all support positions as there are for instructional positions? (Please select only one answer.)

	Percent of All School Division Responses Received
Yes, for all support positions	25%
Yes, for some support positions	31%
No, no specific support standards needed	44%

If you answered yes for either some or all support standards, what recommendations do you offer for support staffing? The following observations are made regarding the majority of respondents who indicated either "no specific standards" or "some specific standards":

- School divisions should have the flexibility to staff according to individual needs.
- Standards are needed for central office staffing, custodial, bus drivers and nurses.
- Existing standards and funding should be maintained.

2. Of the positions noted below, which fall into the SOQ support category, which are the five most critical to your division in regards to student achievement? Please check exactly five (5).

Position	**Rank Among All School Divisions Responding to Survey**
Instructional Professional	1
Superintendent	2
Technology Professional	3
Assistant Superintendent	4
Administration Administrative	5
School-Based Clerical	6
Operations & Maintenance Professional	7
Instructional Technical Clerical	8
Attendance & Health	9
Support Technology Standard Professional **and** School Nurse	10
Administration Technical Clerical	11
Operations & Maintenance Technical Clerical	12
Technology Technical Clerical	13

3. Do you have any recommendations regarding revisions to the staffing standards for: 1) career and technical education (CTE); 2) special education; and/or 3) gifted education? Check all that apply.

Area	**Percent of All School Division Responses Received**
CTE	29%
Special Education	29%
Gifted Education	25%
None of the above apply	61%

If you checked any or all of these categories, what are your recommendations?
Respondents who offered recommendations had the following observations:

- Career and Technical Education (CTE) class size ratios are too restrictive and should be reviewed.
- Staffing in all three areas should be based on local needs.
- Specific standards for gifted and talented are needed.
- Staffing standards for special education should be increased.

4. Does your division employ more staff than what is prescribed in the SOQ for instructional and/or support positions?

	Percent of All School Division Responses Received
Yes	89%
No	11%

If yes, what are your division staffing standards? All survey respondents indicated staffing standards set by the SOQ are exceeded. The following general observations are noted:

- Many respondents provide staff according to student/school needs.
- Many respondents indicate that more building-level administrators and clerical staff are employed than are required by the SOQ.
- Elementary staffing ratios ranged from 12 students to one teacher with 1 to 22:1 ratio in K-3 and an 18:1 to 25:1 ratio in grades 3-6.
- A number of respondents had no specific standards or did not include standards in their narrative information.

5. On a scale of one to seven, please rank the categories in this table according to the greatest challenges that affect staffing within your school division. Rank each category according to a scale of 1 to 7, with one being the area of greatest challenge and 7 being the area of least challenge.

Challenges	**Rank Among All School Divisions Responding to Survey**
Population of Special Education Students	1
Population of Economically Disadvantaged	2
Parental Involvement	3
Transient Student Populations	4
Population of English Language Learners	5
Teacher Shortages	6
School Division Staff Turnover	7

For each of these areas, school divisions were asked: "What staffing standards are needed in order for you to meet this challenge?" Also, divisions were asked the following: "If your division faces challenges not listed above, please provide additional detail." The following observations were noted in each of the areas of challenge and are grouped from the greatest challenge to the least challenge.

Special Education

- More support personnel are needed, such as, speech pathologists, physical therapists, occupational therapists, vision impaired teachers, hearing impaired teachers, etc.
- Coursework requirements need to be reduced for persons who hold endorsements in other areas to gain a teaching endorsement in special education. Increased funding and support for special education teachers is needed to meet the federal highly qualified standard.
- Class sizes and caseloads need to be lowered.
- More assistance for regular education teachers is needed with the use of the inclusion model.

Economically Disadvantaged

- Most survey respondents ranked this as one of the top three challenges.
- Many respondents cited the need for additional staffing and training.
- Staffing should be based on the number of children who are disadvantaged to allow divisions to meet the student needs.
- More parental and community outreach support is needed for this category.

Parental Involvement

- There is a need for more intervention (student services) staff to work with parents particularly those parenting at-risk students.
- There is a need for more attendance officers.
- Most respondents ranked this from 4th through 6th with many ranking it 7th (lowest).

Transient Students

- This is not a significant challenge for most respondents.
- Some survey respondents cited the need for additional staff in this area.
- Some survey respondents indicated that additional support services are needed for these students.

English Language Learners (ELL)

- This area provides moderate challenge for most respondents.
- Flexibility in staffing is needed to meet the needs of the locality.
- Many survey respondents had no comments or cited a low enrollment of ELL students.

Teacher Shortages

- Small and rural school divisions cited difficulties in recruiting and retaining teachers.
- Shortages in mathematics and science teachers were noted by several divisions.
- Some respondents cited the need for salary incentives to help retain teachers.

Staff Turnover

- This area was not highly ranked as a challenge.
- Recruitment and retention is a problem in divisions paying lower salaries.
- Finding highly qualified teachers in mathematics, science, and other select endorsements is a challenge.
- There is a need for competitive salary and benefit packages in smaller school divisions.

6. What kind of flexibility do you need within Standard 2 for 2009-2010 and beyond? Is there a specific area or student population in your division that would benefit from increased flexibility? Should Standard 2 be modified to provide flexibility?

	Percent of All School Division Responses Received
Yes	58%
No	42%

Note: Percentages apply only to the last part of Question 6 -- whether Standard 2 should be modified to provide flexibility.

If you answered yes, then please provide additional detail. The following observations are noted:

- School divisions should be provided flexibility when and if state funding is reduced.
- School divisions should be allocated a total number of administrative and support positions based on student population and allowed the flexibility to determine how those positions should be deployed.
- Flexibility is needed in the use of funds for instructional technology resource teachers.
- More flexibility and support must be given to smaller divisions as these divisions do not have the same resources to oversee instruction or specialize in one subject area as larger divisions. When an overall ratio is used to determine funding and positions, equitable services are not provided and some small divisions may appear overstaffed.
- SOQ funding should be based on more realistic staffing ratios that reflect prevailing practices in Virginia.
- Maximum class size requirements should be eliminated.

7. School divisions receive funding related to the Standards of Quality that is used for both instruction and support services. School divisions are permitted to use funding for support services in the SOQ to provide instruction in the classroom. Keeping this in mind, what percent of the SOQ support services funding that your division receives is used to provide instruction at either the school or classroom level? (This question relates to positions that deliver instruction directly into the classroom.)

Range	Percent of All School Division Responses Received
0 to 10%	27%
10% to 25%	12%
25% to 50%	13%
More than 50%	48%

8. What percent of your support services funding is used to support schools by contracting for services?

Range	Percent of All School Division Responses Received
0 to 10%	88%
10% to 25%	11%
25% to 50%	0%
More than 50%	1%

Please name the top three areas where contractual services are used. The top three areas appear to be the following:

- Special education services (occupational therapy, physical therapy, evaluations, speech, etc.)
- Facilities maintenance
- Technology/software support

9. What other comments do you have regarding Standard 2? The following observations are noted:

- The SOQ requires the local school board to provide support services that are necessary for the efficient and cost effective operation and maintenance of schools. Flexibility for the deployment of resources should remain with the local governing body and support staff standards should not be set on a statewide level. Geographic distribution, age, and number of facilities will drive local needs and cannot be addressed adequately with standards.

- Prevailing staffing standards have enabled students to meet Standards of Learning (SOL) and Adequate Yearly Progress (AYP) requirements and should be

supported in the future to ensure students' continued success. Divisions should be allocated a total number of administrative and support positions based on student population and allowed the flexibility how best to deploy those resources.

- Many of the SOQ staffing requirements should be improved. In addition, neither the governor nor the legislature should reduce the current staffing formula. Any changes to the funding formula that decrease the number of staff will have a direct impact on the lives of students and the efficient operation of schools.

Part II – Flexibility Language

1. How many reading specialists will you employ for the 2009-2010 school year? Of these, how many will be employed using Early Intervention Reading Initiative funds?

Those school divisions responding to the survey will employ over 1,350 reading specialists, with over 100 of these specialists funded from Early Intervention Reading Initiative funds. The following table summarizes how these specialists are being used statewide:

Percent of Responding School Divisions Employing Reading Specialists	96%
Percent of Responding School Divisions Using Early Intervention Reading Initiative Funds	33%

2. How many mathematics specialists will you employ for the 2009-2010 school year? Of these, how many will be employed using Algebra Readiness funds?

Those school divisions responding to the survey will employ over 224 mathematics specialists, with over 38 of these specialists funded from Algebra Readiness funds. The following table summarizes how these specialists are being used statewide:

Percent of Responding School Divisions Employing Mathematics Specialists	54%
Percent of Responding School Divisions Using Algebra Readiness Initiative Funds	21%

3. How many additional teachers above the minimum required by the SOQ will be employed using funds from the SOQ Prevention, Intervention, and Remediation account to supplement instruction to identified students who are English Language Learners for the 2009-2010 school year?

Those school divisions responding to the survey will employ 126 additional teachers.

Percent of Responding School Divisions Employing Additional Teachers	31%

4. How many of Data Coordinators, Instructional Technology Resource Teachers (ITRTs), and/or Blended positions will be employed using funds from the SOQ ITRT funding for the 2009-2010 school year?

- More than one-half of the responding school divisions reported employing instructional technology resource teachers.
- About one-third of responding school divisions reported employing both a Data Coordinator and an Instructional Technology Resource Teacher.
- A smaller percentage of school divisions reported employing some kind of blended position.

Part III: Data Collection - Other General Assembly Reporting Requirements (Resolutions)

1. HJ651, Project Lead the Way. Will your school division participate in this project for the 2009-2010 school year?

	Percent of All School Division Responses Received
Yes	14%
No	86%

If no, does your school division plan to participate in this program at some point in the next three years (up to 2011-2012 school year)?

	Percent of All School Division Responses Received
Yes	40%
No	60%

2. HJ652, K-8 Mathematics Specialists. Will your school division employ K-8 Mathematics Specialists for the 2009-2010 school year?

	Percent of All School Division Responses Received
Yes	44%
No	56%

If yes, how will these positions be funded?

	Percent of Responding School Divisions That Employ Mathematics Specialists
State funding from existing intervention, remediation, and at-risk funding	18%
Other State Funds	12%
Federal Funds	25%
Local Funds	29%
Other	16%

Board Findings

After hearing public comment during the time period from May 1 to July 31 and after deliberating on both the findings from the consultant and on the school division survey results, the Board came forward at its September 2009 meeting with a set of policy directives and with a list of issues that need further study.

Policy Directives

The policy directives are as follows:

- Enhance the Standards of Quality (SOQ) so that the Commonwealth's basic foundation program for K-12 public education reflects a comprehensive educational program of the highest quality.
- Provide clarity and greater transparency in SOQ funding with the goal of maintaining the Commonwealth's commitment to public education funding at the state and local levels and encouraging a continued emphasis on school-based instructional services.
- Provide greater flexibility to school divisions in using non-instructional personnel funding for instructional support services.
- Support the appropriateness of establishing ratio standards for individual categories of "support service" positions as is the current practice used for instructional personnel.
- Advocate against permanent structural changes to the Standards of Quality that result in decreased funding for K-12 public education.
- Begin building a more comprehensive basic foundation program by including in the SOQ gifted, special education, and career and technical staffing ratios and certain incentive programs that have become core components of K-12 educational programs statewide and currently funded in the Appropriation Act.

- Set priorities for the Board's unfunded SOQ recommendations from previous years so that these instructional staffing standards can be fully implemented in future years.
- Begin to address the Board's school leadership priorities of requiring a principal in every school and increasing the number of assistant principals in schools with the greatest need.
- Mitigate the perverse incentive of reducing a school division's special education funding when it mainstreams students with disabilities into general education classrooms or uses Response to Intervention (RtI) and/or other instructional supports to reduce the number of students identified as needing special education services.
- Provide additional policy guidance and direction to school divisions offering alternative or nontraditional educational programs, such as the Individual Student Alternative Education Program (ISAEP).

In order to accomplish these directives, the Board identified the following revisions needed to language in the current SOQ:

- Codify the Board of Education's recommendation that was included in the 2009 Appropriation Act providing flexibility in the use of existing funds for hiring reading specialists, mathematics specialists, data coordinators, and instruction of English language learners.
- Codify the provisions of the Early Intervention Reading Initiative and the Algebra Readiness program by including them in the Standards of Quality and requiring all school divisions to provide these interventions with funding currently appropriated for these incentive programs.
- Codify the Appropriation Act provision that the Standards of Quality include a minimum of 58 licensed, full-time instructional positions per 1,000 students, including instructional positions for special education, gifted education, and career and technical education.
- Codify the staffing standards for special education (currently in regulations), gifted education (currently in the Appropriation Act), and career and technical education (currently in regulations).
- Provide school divisions the flexibility to deploy assistant principals to the schools with the greatest needs, so long as they employ a sufficient number of assistant principals divisionwide to meet the total number required in the current SOQ staffing requirement.
- Define the categories of personnel who make up "support services," specify how those positions are funded, and require transparency in the use of funds by mandating divisions publicly report the state and local amounts budgeted and expended for each category.

- Permit school divisions to use funds for support services to provide additional instructional services and include instructional services as a separate category to be reported publicly.

The appendices to this report contains a chart detailing these directives as well as draft language which modifies the SOQ.

Issues for Further Study

As resources become available, the Board expressed interest in conducting a comprehensive study of the following complex funding issues, with a report of the findings to the Governor and General Assembly for consideration as part of the 2010 review of the SOQ.

- The feasibility of converting the prevailing costs for each major category of the "support services" positions into ratios (for example, based on positions per 1,000 students), and including ratios for some or all of the categories in the Appropriation Act.
- The feasibility of establishing alternative staffing approaches to provide school divisions with additional instructional resources to address identified needs. This could include ratios based on positions per 1,000 students for assistant principals, school counselors, and library-media specialists that would reduce funding "cliffs." It could also include assigning weights for students who may be at-risk and require additional support, including special education services, services to English language learners, and services to disadvantaged students.
- The feasibility of creating a special education incentive fund or other funding methodologies to mitigate the perverse incentive of reducing a school division's special education funding when it mainstreams students with disabilities into general education classrooms or uses Response to Intervention (RtI) and/or other instructional supports to reduce the number of students identified as needing special education services.
- The feasibility of updating technology staffing ratios, taking into consideration the increased role of technology in instruction, assessment, and operations since staffing standards were first established in the SOQ.
- The feasibility of updating career and technical education staffing ratios, taking into consideration the (i.) implementation of new curricular pathways that require high-tech equipment and specialized instruction and (ii.) anticipated increased enrollments in CTE courses given the newly created standard technical and advanced technical diplomas.

Appendix C to this report contains a chart detailing these issues.

VIRGINIA BOARD OF EDUCATION

Report

APPENDICES

VIRGINIA BOARD OF EDUCATION: REVIEW OF THE CURRENT STANDARDS OF QUALITY

October 2009

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Appendix A: Item 140.C.5.k.3) of the 2009 Appropriation Act

"The Board of Education shall review the current Standards of Quality to evaluate the appropriateness of the existing staffing standards for instructional positions and the appropriateness of establishing ratio standards for support positions, with the objective of maximizing resources devoted to the instructional program. The findings of this review, its associated costs, and its final recommendations for rebenchmarking shall be submitted to the Governor, the Chairmen of House Appropriations and Senate Finance Committees and the Joint Subcommittee on Elementary and Secondary Education Funding established pursuant to Item 1, paragraph H. of this Act no later than November 1, 2009."

Appendix B: APA Report

A PRELIMINARY REVIEW AND ANALYSIS OF THE VIRGINIA STANDARDS OF QUALITY

REPORT TO THE VIRGINIA DEPARTMENT OF EDUCATION

Prepared by

Augenblick, Palaich and Associates
Denver, CO

September 2009

Introduction

This report was prepared by Augenblick, Palaich and Associates (APA) in response to a request (Informal Request for Proposals, RFP # DOE 2009-11, issued on April 15, 2009) from the Virginia Department of Education (VDOE) to "review and evaluate the current Virginia Standards of Quality (SOQ) as to the appropriateness of the existing K-12 staffing standards for instructional positions and the establishment of ratio standards for support positions." APA responded to the RFP and was awarded a contract to undertake the services it had proposed in May 2009.

APA is an education consulting firm that was founded in 1983 and is located in Denver, Colorado. Much of APA's work has been for state-level policy makers in the area of school finance, including developing state aid allocation systems, evaluating school finance formulas, and providing technical assistance on education funding-related issues. APA has made significant contributions to designing the state aid formulas of several states, including Colorado, Kansas, Kentucky, Louisiana, Maryland, New Jersey, and Pennsylvania. In recent years, APA has focused its attention on the adequacy of education resources, which has required the development of procedures to cost out the resources school districts with different characteristics need in order to meet state student performance expectations.

In order to review and evaluate Virginia's Standards of Quality, APA undertook several tasks. We: (1) conducted a review of the personnel ratios used in other states or recommended by established organizations and the research that might support specific ratios; (2) reviewed the available efficiency review reports for school divisions in Virginia (located at: http://www.doe.virginia.gov/VDOE/efficiencyreview.html); (3) conducted phone interviews with state officials in two states that use personnel ratios as the basis of allocating state aid to school districts; and (4) analyzed data provided by VDOE comparing the numbers of SOQ personnel for which school divisions receive funding based on SOQ staffing standards, or based on prevailing costs, and the numbers of personnel school divisions actually employed for corresponding SOQ categories, as found in the Annual School Report, in order to understand what relationships might exist between numbers of personnel per 1,000 students and division characteristics such as their size (enrollment levels) and education needs.

The Role of Personnel Ratios in Allocating State Aid to School Divisions in Virginia

Virginia's School Finance System

Like almost every other state, Virginia uses a form of the "foundation program" (sometimes referred to as a "minimum foundation program" because it sets a base) as the primary basis of allocating state aid to school districts (divisions). Under a foundation program, a state sets a target level of funding for each school district and divides that amount between state and local sources based on the relative fiscal capacities of school districts. The funding target level can be set in a variety of ways, from simply specifying a per student amount (e.g., $4,000) to setting an amount and adjusting it by factors related to uncontrollable cost pressures associated with student and district characteristics (such as students with individualized education programs or small school districts) to building the amount based on specific

expenditures, such as those for personnel and textbooks. For the Standards of Quality, Virginia calculates the target revenue level for each school division primarily on the basis of numbers of personnel of different types and the salary levels assigned to those types of personnel; it also uses school division expenditure data primarily to fund support costs.

Many states that are members of the Southern Regional Education Board (SREB) have used approaches similar to Virginia's in setting the target funding levels for school districts over the past 40 years; however, several states have moved to a dollar amount per student with adjustments for student and district uncontrollable cost pressures (such as Florida, Kentucky, Louisiana, Maryland, and Mississippi). North Carolina goes even further than Virginia in precisely defining the foundation target for each district by using the actual salaries that each individual employee is eligible for based upon the statewide salary schedule and their individual education level and experience (and the state pays the entire cost rather than sharing it with local districts).

Under almost all foundation programs, school districts are free to supplement foundation funding with local revenues without limit. This is easier to do when school districts are fiscally independent (that is, they, through their school boards, determine whether additional revenue is desired and, if so, set local tax rates). For example, in Kentucky, school districts can generate up to 15 percent of foundation revenue through school board decisions and an additional 30 percent with voter approval. However, in Virginia, school districts are dependent upon their local governing bodies (county boards of supervisors and city councils), and cannot make such decisions.

Strengths and Weaknesses of Using Personnel Ratios in a Foundation Program

The use of personnel ratios as part of a school finance system serves several purposes. First, personnel ratios create a direct linkage between state programmatic requirements and the funding allocated to school districts; in many states programmatic requirements are disconnected from funding, sometimes creating what are referred to as unfunded mandates. Second, to the extent that there is a close relationship between the numbers of staff the ratios assure and the numbers of staff that are needed either to deliver the educational services required by the state or to achieve the state's educational objectives, they increase the likelihood that all districts will meet state expectations. Third, the use of personnel ratios increases the probability that all districts will provide similar services so that students across the state are treated in the same fashion, depending upon the autonomy of the local school board. Finally, the requirement that all districts employ specific numbers of staff in several personnel categories assures that districts that might otherwise not choose to employ certain kinds of staff will do so.

Of course, the use of personnel ratios has its weaknesses. The use of ratios may not take into account the numbers of personnel needed in districts with different characteristics or special circumstances. When a state holds school districts accountable for student performance, as most states do under what is sometimes referred to as "standards-based reform," the use of personnel ratios undermines local responsibility to organize education services by specifying how services should be delivered. And, since local governing bodies may appropriate local funding to school districts to employ additional personnel,

the existence of minimum personnel requirements does not assure resource equity across school districts.

Virginia's Personnel Ratios

Virginia's use of personnel ratios to drive the allocation of state aid to school divisions is part of the state's employment of Standards of Quality for public education. The Standards of Quality (SOQ) are referred to in Article VIII of the Virginia Constitution, under which they are to be "determined and prescribed" by the State Board of Education, subject to revision only by the Virginia General Assembly, which has the responsibility to determine the manner in which funds are to be provided that support the SOQs, including apportioning their cost between the Commonwealth and local governments. Standards of Quality were first adopted by the State Board of Education in 1971.

There are eight Standards of Quality, the second of which prescribes staffing standards (primarily for core instructional positions) for school divisions, which are the primary determinant of funding for each of the state's school divisions. The staffing standards are personnel ratios (students to personnel or personnel to students, sometimes expressed in per 1,000 student terms) and class size caps that both specify the numbers of personnel that each school division should employ and serve as the basis for determining, in large part, how much revenue each school division needs. Some personnel ratios are expressed in division-wide terms while others are expressed in school-wide terms. Personnel ratios exist for specific types of instructional staff and some support staff. Some ratios provide basic personnel while others reflect student characteristics, such as students with individualized education programs and students who are English language learners. Several are related to school characteristics, such as school size, or whether a school is an elementary, middle, or high school. In essence, the application of all personnel ratios to the numbers of students in schools and school divisions determines a roster of personnel for each school division, which can be multiplied by standard salary and benefit rates to determine the total cost for each school division. School divisions can choose to both employ additional personnel and pay all personnel at rates above those used by the state to determine the revenue needs of school divisions, although any added costs are likely funded through resources other than those specifically related to a particular ratio.

An example of a division-wide ratio is the one that applies to classroom teachers in grades one, two, and three, which is based on 24 students per teacher. An example of a school-wide ratio based on school size is the one that applies to librarians, which provides a part-time librarian for elementary schools with fewer than 300 students, a full-time librarian for elementary schools with 300 or more students, a half-time librarian for middle and high schools with fewer than 300 students, a full-time librarian for middle and high schools with between 300 and 999 students, and two full-time librarians for middle and high schools with 1,000 students or more. These kinds of ratios have built in "cliffs" whereby the number of personnel shifts at a specific point (such as 300 students), below which point one figure is used and above which point a different number is used; this approach does not permit any "smoothing" as enrollment changes.

Other ratios, such as the one for art, music, and physical education teachers in grades kindergarten through five is expressed as five staff per 1,000 students, which produces exactly five staff at 1,000

students but fewer staff as the number of students differs – this ratio would provide three staff at 600 students and 1.5 staff at 300 students, thereby avoiding a "cliff" at any point. A last type of ratio is the one used to provide staff for prevention, intervention, and remediation, which is based upon a population of children needing services (determined by free lunch factors) according to a pupil teacher ratio in range of 10:1 to 18:1, based upon division-level failure rates on Standards of Learning (SOL) English and mathematics tests for all students.

In the case of some support positions, school divisions are required to provide services necessary for the efficient and cost-effective operation of the schools although funding is based on prevailing statewide expenditures (as in pupil transportation and plant operations and maintenance).

Additional Research

Efficiency Studies

As part of this study, APA reviewed all of the division level efficiency studies conducted in the past few years, which were posted on the Virginia Department of Education's website.[1] The studies were undertaken by a few different companies and have been completed for 34 school divisions to date. The earliest study was posted in January 2004, with the most recent study posted in May 2009. The efficiency studies look at a number of areas of division operations, ranging from educational service delivery to transportation. APA focused its review on any information regarding the SOQ ratios.

APA found very little information in the efficiency studies that would suggest needed changes to the current SOQ ratios. Almost uniformly the studies indicate that districts are currently meeting the minimum SOQ ratios. The SOQ ratios examined in the efficiency studies are generally instructional ratios such as those for teachers, principals and assistant principals. The studies often note the districts are meeting the SOQ ratios and then change the analysis to division comparisons to determine if a district is staffing in an efficient manner, rather than analyzing whether ratios should be increased or decreased. In a few cases the SOQ ratios are used as an efficiency measure. If a district has more staff than the SOQ ratios require the study might suggest a reduction in the level of staffing; this was almost always related to school level administration. Again, overall the studies provided little guidance as to any needed changes to the SOQ ratios.

Phone Calls

APA also agreed to interview states that use personnel as the principal factor in funding school districts. With the help of Michael Griffith, Senior Policy Analyst from the Education Commission of the States (ECS), APA identified six states that use this type of funding system. The states are Alabama, Delaware, Idaho, North Carolina, Tennessee and West Virginia. It is important to note that none of these states fund exactly like Virginia. An example of the differences is that every state has some sort of ratio for teachers, but some states include funding for teachers such as art or P.E. teachers in that figure while others do not. These differences make it very hard to compare specific ratios state to state. However,

[1] http://www.doe.virginia.gov/VDOE/efficiencyreview.html

after further examining the six states APA identified four states to contact, Alabama, Delaware, North Carolina and Tennessee. Table 1 below describes the allocations for the four states APA contacted. Again, it is important to remember that the ratios are not necessarily comparable since the systems implement the ratios differently. After repeated attempts to make contact with each of the four states APA was able to conduct interviews with Alabama and North Carolina.

In each of the interviews APA asked questions, such as:

1. Where did the ratios come from?
2. Are the ratio levels correct? Should any of them be higher? Lower?
3. Should other ratios be used?
4. As far as support staff goes, do you think any ratios are particularly important?

APA spoke to Craig Pouncey with the Alabama Department of Education. He mentioned that the ratios were set in 1995 and applied based on the ADM. The ratios used in Alabama focus on all certified teaching staff positions for the districts. At this point Alabama is comfortable with the ratios that are used. The state funds administrators and support staff based on the Southern Association of Colleges and Schools (SACS) ratios from 2000. The state has recently created funding streams for both technology coordinators and nurses. Both position types have been funded through line item appropriations that can be eliminated at anytime. Other operational staff members are allocated based on per teaching unit amounts.

The interview in North Carolina was with Philip Price from North Carolina Department of Education. He mentioned that North Carolina has used the personnel ratios since 1985. A full study was done at that time to set the ratios in order to meet the staffing needs of districts. Though some of the ratios have been changed since, notably the K-3 staffing ratio, many ratios have remained the same. The system has been challenged in court and been upheld. Any changes that have been made to the ratios have generally been to increase staffing levels. The state currently allocates a dollar amount per ADM to allow districts to decide what type of non-instructional support to provide with those dollars. The state is unique in that it guarantees a minimum salary amount for teachers, principals, assistant principals and guidance counselors. This means the district gets a minimum level of funding but also means they have little flexibility in how they use the funds allocated for these types of personnel. However, school districts in North Carolina do not have full autonomy like divisions in Virginia do.

Since APA was not able to interview a representative from either Delaware or Tennessee directly, APA examined existing documents regarding each state's funding system. The information for both states, in addition to Alabama and North Carolina, is contained in Table 1 on the following page. Information for Virginia is also included for comparison.

Table 1

Comparison of Staffing Allocations Between Virginia and Five Other States

State	Principal	Assistant Principal	Classroom Teachers	Resource Teachers	Instructional Technology Resource Teachers and Technology Support	English Language Learner (ELL) Teachers	Librarian	Guidance Counselor	Clerical Staff	Professional Instructional Positions and Aides	Nurses
Alabama	1 principal per school	Varies based on size of school and varies based on type of school. For Elementary, 0 below 660 students, .5 between 660 and 879, 1 between 880 and 1099, 1.5 between 1100 and 1319, 2 1320 and above	1 per 13.8 (grades K-3); 1 per 21.4 (grades 4-6); 1 per 20.1 (grades 7-8); 1 per 18.0 (grades 9-12)				Varies based on size of school and varies based on type of school. Cliff style of funding.	Varies based on size of school and varies based on type of school. Cliff style approach to funding.			One per system and an additional $35.44 per ADM for additional nurses
Delaware*	1 for each 15 or more units in a school	1 for each 30, 55, 75, 95 units in a school	1 per 34.8 (half-day K); 1 per 17.4 (grades 1-3); 1 per 20 (grades 4-6); 1 per 20 (grades 7-12)						1 for each 10 units for first 100 units, then 1 for each 12 units over 100 units	2 in lieu of a teacher in certain Special Education settings	1 for each 40 units (Special Education)
North Carolina	Any school above 100 students entitled to a principal	One month of assistant principal time per 80 ADM	1 per 18 (grades K-3); 1 per 22 (grades 4-6); 1 per 21 (grades 7-8); 1 per 24.5 (grade 9); 1 per 26.64 (grades 10-12)	Base allocation with a minimum of one teacher assistant per eligible LEA		Base allocation with a minimum of one teacher assistant per eligible LEA	Part of Certified Instructional Support allocation of one per 200.10 ADM. District controls the allocations.	Part of Certified Instructional Support allocation of one per 200.10 ADM. District controls the allocations.		Can be converted from the Certified Instructional Support allocation at two Non-Certified positions for every one certified position.	Part of Certified Instructional Support allocation of one per 200.10 ADM. District controls the allocations. Minimum of one per 3,000 ADM

*In Delaware, a district earns one unit for every 20 regular secondary education students, 17.4 regular elementary students, 10 mild special education students, six moderate special education students or four severe special education students. Staffing allocations are then based on the number of units a district has. If a district has more than half of the number of students required to generate a unit, the funds are allocated for a full unit. (Report on Education Funding in Delaware, LEAD Committee 2008)

Table 1 (continued)
Comparison of Staffing Allocations Between Virginia and Five Other States

State	Principal	Assistant Principal	Classroom Teachers	Resource Teachers	Instructional Technology Resource Teachers and Technology Support	English Language Learner (ELL) Teachers	Librarian	Guidance Counselor	Clerical Staff	Professional Instructional Positions and Aides	Nurses
Tennessee	1 half-time per school (with less than 225 students); 1 full-time per school (225 students or more)	1 half-time per school (elem with 660-678); 1 full-time per school (elem with 880-1,099 students); 1.5 per school (elem with 1,100-1,319 students); 2 per school (elem with more than 1,319 students); 1 half-time per school (secondary with 300-649 students); 1 full-time per school (secondary with 650-999 students); 1.5 per school (secondary with 1,000-1,249 students); 2 per school (secondary with more than 1,250 students + 1 for each additional 250 students)	1 per 20 ADM (grades K-3); 1 per 25 ADM (grades 4-6); 1 per 25 ADM (grades 7-9); 1 per 22.08 ADM (grades 10 12)	1 art teacher per 525 ADM (grades K-6); 1 music teacher per 525 ADM (grades K-6); 1 PE teacher per 350 ADM (grades K-4); 1 PE teacher per 265 ADM (grade 5-6)		1 ELL instructor per 30 ELL students; 1 ELL translator per 300 ELL students	1 half-time librarian per school (elem & middle with 265 or fewer students); 1 full-time librarian per school (elem & middle with 265-439 students); 1.5 librarian per school + 0.5 assistant (elem & middle with 440-659 students); 2 librarians per school + 1 assistant (elem & middle with 660 or more students); 1 half-time librarian per school (high with 299 or fewer students); 1 full-time librarian per school (high with 300-999 students); 1.5 librarian per school (high with 1,000- 1,499 students); 2 librarians per school + 1 assistant per each additional 750 students (high school with 1,500 or more students);	1 per 500 ADM (grades K-6); 1 per 350 per ADM including vocational education (grades 7-12)		1 per 16.67 vocational FTEADM (grades K-3); 1 SpED assistant per 60 SpEd students, 1 instructional assistant per 75 ADM (grades K-6); SpEd staff based on disability	1 per 3,000 ADM
Virginia	Principals in elementary schools, one half-time to 299 students, one full-time at 300 students; principals in middle schools, one full-time, to be employed on a 12 month basis; principals in high schools, one full-time, to be employed on a 12-month basis	Assistant principals in elementary schools, one half-time at 600 students, one full-time at 900 students; assistant principals in middle schools, one full-time for each 600 students; assistant principals in high schools, one full-time for each 600 students	(i) 24:1 in kindergarten with no class being larger than 29 students, if the average daily membership in any kindergarten class exceeds 24 pupils, a full-time teacher's aide shall be assigned to the class; (ii) 24:1 in grades 1, 2, and 3 with no class being larger than 30 students; (iii) 25:1 in grades 4 through six with no class being larger than 35 students; and (iv) 24:1 in English classes in grade 6 through 12.	Local school boards shall employ five full-time equivalent positions per 1,000 students in grades kindergarten through five to serve as elementary resource teachers in art, music, and physical education.	Local school boards shall employ two full-time equivalent positions per 1,000 students in grades kindergarten through 12, one to provide technology support and one to serve as an instructional technology resource teacher.	17 full-time equivalent instructional positions for each 1,000 students identified as having limited English proficiency.	Librarians in elementary schools, one part-time to 299 students, one full-time at 300 students; librarians in middle schools, one-half time to 299 students, one full-time at 300 students, two full-time at 1,000 students; librarians in high schools, one half-time to 299 students, one full-time at 300 students, two full-time at 1,000 students	Guidance counselors in elementary schools, one hour per day per 100 students, one full-time at 500 students, one hour per day additional time per 100 students or major fraction thereof; guidance counselors in middle schools, one period per 80 students, one full-time at 400 students, one additional period per 80 students or major fraction thereof; guidance counselors in high schools, one period per 70 students, one full-time at 350 students, one additional period per 70 students or major fraction thereof	Clerical personnel in elementary schools, part-time to 299 students, one full-time at 300 students; clerical personnel in middle schools, one full-time and one additional full-time for each 600 students beyond 200 students and one full-time for the library at 750 students; clerical personnel in high schools, one full-time and one additional full-time for each 600 students beyond 200 students and one full-time for the library at 750 students.	if the average daily membership in any kindergarten class exceeds 24 pupils, a full-time teacher's aide shall be assigned to the class	No specific staffing allocation, but covered in prevailing support costs

Literature Review

Additionally, APA conducted a review of relevant literature. Over the years, there have been a plethora of studies on staffing ratios. The research can be categorized into three categories: (1) Empirical research; (2) Papers that utilize the research to produce conclusions on appropriate ratios; and (3) Accreditation standards. Some of this research can be used as the basis to set minimum or maximum staffing ratios in schools that may improve the odds of attaining particular student outcomes. For other staff positions, the relationships between ratios and outcomes are less direct. For example, clerical staff may not interact with students at all, yet the need for at least some clerical staff within the school is not disputed. Research on the direct and indirect relationships is presented in this analysis.

This analysis presents the empirical basis for lower student-to-staff ratios and then presents more specific information on suggested ratios (if available in the literature).

Teachers

There is a wide body of literature documenting the positive impact of small class sizes for students in grades K-3. Specifically, the research documents that smaller classes are especially beneficial for reading and math achievement and for low-income and minority students (Robinson, 1990; Achilles, 1999; Gerber, Finn, Achilles, & Boyd-Zaharias, 2001; Grissmer, 1999; Nye, Hedges, & Konstantopoulos, 2002; Finn & Achilles, 1999; Miller, 2002).

An early meta-analysis of class sizes studies was completed by Glass and Smith in 1979. This meta-analysis concluded that class sizes of 20 students or fewer can have a positive effect on academic achievement (Glass & Smith, 1979). An evaluation of a class size reduction policy in Indiana documents the positive impacts of class sizes of 15 students or less (Chase, Mueller, & Walden, 1986). Probably the most influential study to date is the Tennessee Project STAR, a large-scale randomized study of students in grades K-3. Data from this study indicated that students in classes with 13-17 students outperformed students in classes with 22-26 students, even when the larger classes added an aide (Word, et al., 1990; Gerber, Finn, Achilles, & Boyd-Zaharias, 2001). Subsequent analysis of STAR data has shown that small classes in the early grades produce lasting benefits for students, such as higher high school graduation rates (Krueger & Whitmore, 1998; Cohen, Miller, Stonehill, & Geddes, 2000; Egelson, Harman, Hood, & Achilles, 2002; Finn, Fox, McClellan, Achilles, & Boyd-Zaharias, 2006; Finn, Gerber, & Boyd-Zaharias, 2005; Nye, Hedges, & Konstantpoulos, 2000).

While the research on class sizes in the early elementary grades is substantial, there is little or no research to suggest that small middle or high school class sizes are beneficial to student performance. According to Odden et. al., (2005), most comprehensive school reform models propose class sizes of 25 or less (Stringfield, Ross, & Smith, 1996; Odden A., 1997). The Northwest Association of Accredited Schools (NAAS) sets an accreditation standard of no more than 160 students per teacher's grading period if on a traditional schedule, 140 students if on a trimester schedule, and 180 students If on a block schedule (Northwest Association of Accredited Schools, 2008). How this translates to actual student-to-teacher ratios and class size is unclear.

At least one author found that small classes not only improve student achievement, but also are more cost effective than regular classes with aides (Grissmer, 1999). It is important to note that student-to-teacher ratios are not synonymous with class sizes. The research indicates that it is important to provide an adequate number of teachers to maintain these class sizes, and allow teachers time for professional development, collaboration, and planning. Additional teachers may also be necessary if the school provides tutoring outside of regular school hours or the school year. The actual number of teachers required to do this may vary significantly due to school schedules and regulations.

Special Education Teachers

A number of studies document the positive impact of smaller student-to-teacher ratios and smaller class sizes on the academic outcomes of special education students (Thurlow, Ysseldyke, Wotruba, & Algozzine, 1993; Keith, Fortune, & Keith, 1993; Keith, Keith, Young, & Fortune, 1993). Special education students often require more personal attention than basic education students. Specifically, one study found that special education students were likely to spend more time engaged and teachers were more active and adaptive when student-to-teacher ratios were lower (The Council for Exceptional Children, 1989). A Virginia study concluded that special education students in smaller classes achieved at higher levels in reading, math, and social studies than their peers in larger classes (Keith, 1993). Researchers in New York reported that larger special education classes were associated with less time spent on academics and higher incidences of misbehavior (MAGI Educational Services, 1995).

One research study found that the maximum special education student-to-teacher ratio was typically 15-to-1 (McCrea, 1996). In the report from Virginia (referenced above), teachers believed that manageable class sizes without paraprofessionals were not much smaller than manageable class sizes with paraprofessionals (Keith, Fortune, & Keith, 1993).

Unfortunately, information on the *optimal* student-to-teacher ratio for special education students is relatively sparse. One of the few existing studies compares special education student-to-teacher ratios of 1-to-1, 3-to-1, 6-to-1, 9-to-1, and 12-to-1 and found that academic engagement, task completion, task success, and instruction were both significantly better under lower ratios (Thurlow, Ysseldyke, Wotruba, & Algozzine, 1993). Another study on class size and special education students concluded that although students performed better under lower ratios, there was no optimal student-to-teacher ratio that should be recommended (McCrea, 1996).

ESL Teachers

Research on class size and student-to-teacher ratios for English-as-a-Second-Language (ESL) students is similar in nature to the research for all students, although the research base for ESL students is considerably smaller. That is, the limited research generally suggests that lower class sizes and student-to-teacher ratios are beneficial, but does not reach any conclusions about optimal class sizes or ratios. For example, programs such as Éxito Para Todos, the bilingual adaptation of Success for All “increases chances of academic success by reducing student-to-teacher ratio”, but does not recommend a particular ratio (Slavin & Madden, 1999).

Another study found that smaller class sizes with less pull-out time positively impact the oral proficiency of ESL students in first grade (Oberg, 1993). Specifically, this study compared the oral proficiency of ESL students in 45-minute classes with six to eight students with the proficiency of ESL students in 90-minute classes with nine to fifteen students (Oberg, 1993). A Texas evaluation of high performing ESL students showed an average ESL student-to-teacher ratio of 24-to-1 (Texas Education Agency and Texas A&M University, Corpus Christi, 2000). In an effort to identify the appropriate student-to-teacher ratio for ELL students, one group of researchers initially recommended providing 0.4 FTE teachers for every 100 ELL students, in addition to tutoring resources (Odden, et al., 2005). Based on input from professional judgment panels, this recommendation was later modified to 1.0 FTE teacher for every 100 ELL students.

School Administrators

APA was unable to locate much research on the impact of student-to-administrator ratios. Because most schools have at least 1 FTE principal, there has not been much research on the differences between schools that have a principal and those that do not. The only study that addressed these ratios was a comparison between California schools that "beat the odds" and other California schools. Schools that "beat the odds" were defined as those that consistently performed at higher levels than predicted by their demographics. This study found that student-to-administrator ratios were lower in elementary schools that beat the odds (Perez, et al., 2007). NAAS also sets a maximum ratio of 550 students per administrator as one of its accreditation standards (Northwest Association of Accredited Schools, 2008).

Clerical Staff

There is also virtually no research on the impact of clerical staff on student achievement. This is not surprising given that clerical staff have little or no direct impact on instruction. Nonetheless, every school needs clerical staff to help manage day-to-day school operations. NAAS recommends one administrative support staff member for each 350 students (Northwest Association of Accredited Schools, 2008).

Instructional Aides

There is very little research on the relationship between instructional aides and academic achievement and what research exists is largely contradictory.

Using data from Tennessee's Project STAR, one researcher concluded that students in smaller K-3 classes outperformed those in larger classes even when an aide was present in the larger classes (Word, et al., 1990). Another study using STAR data examined the short- and long-term effects of teacher aides on student academic achievement. These researchers found little positive impact of teacher aides on student achievement (Achilles, Finn, Gerber, & Boyd-Zaharias, 2000). According to other researchers, students in regular-sized classes with and without aides show little difference in reading achievement (Slavin, 1994; Gerber, Finn, Achilles, & Boyd-Zaharias, 2001). In some cases, students in classes with aides actually performed more poorly than students in classes without an aide (Finn, Gerber, Farber, & Achilles, 2000). In addition, an analysis of achievement and costs concluded that small class sizes were more likely to improve achievement than the presence of aides, and also more cost effective than regular sized classes with aides (Grissmer, 1999).

Nonetheless, some research indicates that instructional aides may be helpful in some situations. One study found that the presence of an instructional assistant may influence reading and language achievement in schools with higher socio-economic levels (Lapsley, Daytner, Kelly, & Maxwell, 2002). Another study concluded that early primary school students who were in a class with an aide for a year or more performed higher on the SAT reading test (Finn, Gerber, Farber, & Achilles, 2000). Finally, an evaluation of a class size reduction policy in Indiana found that achievement scores were higher in classrooms with an instructional assistant than in unassisted classrooms (Lapsley, Daytner, Kelly, & Maxwell, 2002).

Library Staff

The literature indicates that a qualified library media specialist, a larger library staff, and a library staffed for more hours may improve student test performance, grades, reading comprehension, research skills and the ability to express ideas effectively (Baumbach, 2002; Baxter & Smalley, 2003; Lance, 1994; Haycock, 1995; Lance, Rodney, & Hamilton-Pennell, 2000; Smith, 2001).

Specifically, the research recommends that each school library have at-least one full-time certified library media specialist and one full-time support staff member (Baumbach, 2002; Smith, 2001). Another study provides evidence that students from high schools with library media teachers display better research skills in college (Smalley, 2004). NAAS recommends the following staffing ratios: one library media specialist for schools with 500 or fewer students, and one library media specialist plus an unspecified number of additional library media personnel at schools with more than 500 students. The NAAS standards do not require a certified library media specialist for schools with less than 250 students.

Nurses

Research on school nurses indicates that lower student-to-nurse ratios are likely to have positive impacts on student well-being (Bradley, 1998; Fryer & Igoe, 1995; Guttu, Engelke, & Swanson, 2004). An evaluation in Missouri found that as student-to-nurse ratios improved, the length of time spent in the health center decreased and more students returned to class after visiting the health center (Igoe, 2002). In a 2003 meta-analysis, researchers concluded that school nursing strategies that are targeted at specific student populations had positive effects on student academic performance (Maughan, 2003). A Seattle study found that students who were able to receive health care at school demonstrated more classroom attentiveness (Barkan, Pfohman, & Bolan, 2004). Furthermore, this study indicated that school health clinics helped reduce absenteeism, the number of dropouts, and helped improve school safety, student performance, substance abuse problems, and pregnancy rates (Bradley, 1998).

Although no specific student-to-nurse ratios can be recommended by reviewing the literature, the federal government advocates a student-to-nurse ratio of 750-to-1 (U.S. Department of Health and Human Services (2000), *Health People*, 2010). The research on health clinics also indicates that a health clinic at each school with at least one full-time staff member may also be advantageous (Bradley, 1998).

Custodians and Maintenance Workers

There is no research linking custodians and maintenance workers to student achievement. However, these staff members perform essential duties within the school. A set of researchers has developed a formula that they believe takes all custodial duties into account (Odden, et al., 2005). This formula is:

(1 custodian for every 13 teachers + 1 custodian for every 325 students + 1 custodian for every 13 classrooms + 1 custodian for every 18,000 gross square feet) / 4.

One author has also outlined a very detailed formula for estimating the number of necessary maintenance workers. For more information, please see references to the work of Odden, et al., 2005.

Technology Specialist

The research identifies a technology specialist as an integral component of computer and information technology programs (Beglau, 2005; Dexter, Seashore, & Anderson, 2003; Stringfield, Ross, & Smith, 1996; North Central Regional Educational Lab, 2005; Wenglinsky, 2005). A technology specialist typically troubleshoots technology problems, maintains technology, and trains teachers in how to integrate technology into their instruction (North Central Regional Educational Lab, 2005). Studies have found this training to be important to how teachers use technology in their classrooms (Becker, 1994).

Counselors

The literature consistently documents the positive impact on student academic performance and behavior (Gerler, 1985; Prout & DeMartino, 1986; St. Clair, 1989; Lapan, Gysbers, & Petroski, 2001). Specifically, a number of studies conclude that school counseling may decrease inappropriate behavior, improve student-teacher relationships, and improve student ability to stay on task (Baker & Gerler, 2001; Lapan, Gysbers, & Petroski, 2001; Watts & Thomas, 1997). Counselors may also help to improve students' social skills, self-awareness, and other developmental skills (Borders & Drury, 1992; Litrell, Malia, & Vanderwood, 1995; Verduyn, Lord, & Forrest, 1990; Schlossberg, Morris, & Lieberman, 2001). A fairly recent study used regression models to investigate the relationship between student-to-counselor ratios and student discipline. The study found significant substantial decreases in discipline problems as the ratios decreased (Carrell & Carell, 2006). Decreases were especially pronounced among black male students and low-income students (Carrell & Carell, 2006).

Academically, several studies have found that counselors helped students improve their grades (Gerler, 1985; Watts & Thomas, 1997; Lee, 1993). The influence of counselors may continue beyond high school as well. Research has concluded that counselors help students define career plans, increase their aspirations, and reduce drop-out rates (Beardan, Spencer, & Moracco, 1989; Lapan, Gysbers, & Yongmin, 1997; Kaufman, Kiein, & Frase, 1999; Mau, Hitchcock, & Calvert, 1998; Whiston & Sexton, 1998).

NAAS sets its accreditation standard at a ratio of 300 students for each staff member providing guidance and counseling (Northwest Association of Accredited Schools, 2008). The American School Counselor

Association recommends a student-to-counselor ratio of 250-to-1. The Carrell & Carrell (2006) study indicated that this ratio was helpful in reducing discipline problems.

Examining Personnel Ratios in Virginia School Divisions

Defining and Measuring Personnel

In order to help us understand how the SOQ personnel ratios work in Virginia, we felt that it was important to examine data for every school division. We had three objectives in mind when we undertook this examination: (1) to understand the relationship between numbers of personnel allotted to each school division by division characteristics, particularly size (enrollment level) and need (the personnel implications of having students with special needs); (2) to understand the relationship between the actual number of personnel employed as reported by school divisions and the number allotted by SOQs; and (3) to understand whatever variation might exist across school divisions in both allotted and actual numbers of employees. The first objective provides information about whether the personnel ratios are working appropriately while the second objective provides information about how well the personnel ratios represent how districts deliver education services; the third objective allows us to delve into the equity of the system.

In order to undertake these examinations for Virginia as a whole, we asked the VDOE to provide us with data about: (1) the numbers and characteristics of students enrolled in school divisions; (2) the number of employees allotted to each school division in every SOQ personnel category for which a personnel ratio exists; and (3) the number of staff actually employed in every personnel category for which a personnel ratio exists. We made a number of decisions about what data we would examine and how it would be organized based on discussions with VDOE staff and mutual agreement about how to proceed as quickly as possible given the time constraints that existed for our work: (1) we would focus on the 2007-08 year because these data become the basis for cost rebenchmarking in the 2010-2012 biennium; (2) data would be organized into 132 school divisions based upon how school divisions are paid and how Virginia's report card data are aggregated; and (3) certain personnel categories would be aggregated, primarily elementary teaching staff and secondary teaching staff.

In order to examine what personnel are allotted in the SOQ and what personnel are actually employed by a school division, the VDOE provided information to us related to estimating positions generated in the SOQ model using comparable cost and FTE factors. The estimated positions generated by the SOQ model (solely for the purposes of this study) and provided to us by the VDOE are what we view as allotted positions. For the actual positions employed, we used personnel information provided to us from the VDOE as reported by school divisions in the Annual School Report for the 2007-2008 school year, which represent the data that will be used to estimate SOQ costs for the 2010-2012 biennial budget in Virginia. The Annual School Report is a multi-faceted reporting tool that is used for federal reporting and other purposes, not solely for the purpose of generating SOQ costs and positions. Because of the nature of the Annual School Report and the significant burden of reporting that it places on school divisions, it is our understanding that it is not possible to conform the personnel section of this report to a format that is 100 percent compatible to the structure of the SOQ model. Consequently, the

ability to correlate the allotted positions to those actually employed is challenging and needs to be considered when examining variations in the different categories of positions.

We determined that the only way we could compare divisions was to translate numbers of employees allotted or actually employed into numbers of employees per 1,000 students. This is the case because there are variations across school divisions in enrollment and student demographic characteristics. Because of the autonomous nature of Virginia school divisions, this means that every division is likely to have a different number of employees, allotted or actual, which makes it impossible to interpret whether the system is working appropriately. While we could have used the ratio of numbers of actual-to-allotted staff to examine the second objective identified above, and never had to look at employees per 1,000 students, it would have been impossible to examine the first objective without doing so.

Using employees per 1,000 students is useful for several reasons. First, it is easy to interpret: for example, if an SOQ ratio were expressed as one teacher per 25 students, that equals 40 teachers per 1,000 students. Additionally, a standard based on every 1,000 students can be used to compare different categories of personnel to one another, is a more comparable measure across school divisions, and is easy to compare over time.

Before we look at employee figures, it is useful to understand some of the differences that exist across the 132 Virginia school divisions. We obtained 2005-2006 data from the National Center for Education Statistics (NCES of the U.S. Department of Education) in order to look at enrollment and demographic characteristics. We found that the average enrollment of Virginia school divisions was about 9,250 students although 11 divisions had fewer than 1,000 students and 13 divisions had more than 20,000 students. While 31.4 percent of all students were eligible for free and reduced price lunch, in 19 divisions fewer than 20 percent of all students were so eligible and in 14 divisions more than 60 percent of all students participated in the free and reduced price lunch program. On average, 14.0 percent of all students had individualized education programs (IEPs), making them eligible to participate in special education programs, although in four divisions fewer than 10 percent of all students were in special education programs and in six divisions, more than 20 percent of all students were in special education programs. Finally, across the Commonwealth, about 7.1 percent of all students were English language learners, although these students were concentrated in the 15 districts in which more than 15 percent of all students were English language learners. In light of these figures, it is likely that no two school divisions face the same cost pressures based on student demographic characteristics.

Given that we want to understand how the allocation of personnel, both allotted and actual, are related to school division size and need, we had to have ways of measuring these factors. Size is relatively easy – division enrollment can be used. In the case of need, we developed a procedure to assign “weights” to students based on three types of need: participation in special education, eligibility for free lunch, and being a student with limited English-proficiency (LEP). Weights are factors (numbers such as .10 or .85) that estimate the added resources to serve students with different needs relative to students with no special needs (who would be counted, or weighted, at 1.00). The ratio of weighted to unweighted students is an indicator of the relative need of each school division. The weighting factors allow APA to compare the relative levels of need in each district.

For example, if a characteristic contained a weight of .25, indicating that 25 percent more resources were required for that characteristic compared to a student with no special need, then a weight would exist totaling 1.25. If a school division had a total of 2,500 students and 40 percent of those students had that characteristic (2,500 X .40 = 1,000) while 60 percent of the students had no special need (2,500 X .60 = 1,500), then the weighted student count for the division would be 2,750 (1,000 X 1.25 = 1,250) + (1,500 X 1.00 = 1,500.) In this case, the relative need of the division would be 1.10 (2,750/2,500), or 10 percent higher than a district containing only students with no special needs or characteristics.

We used three weights in determining the relative need of Virginia's school divisions: (1) an economically disadvantaged student weight of .25; (2) an LEP weight of .40; and (3) a special education weight of 1.0; they are an estimate of the additional resources spent on each type of student. The weights come from research APA has done around the country and have been similarly applied in studies conducted by APA in other states. In this case, as in the other studies, APA is simply creating a convenient measure of need to help the analysis. The weights are applied to the actual student data for each of Virginia's school divisions. The weights are only being used in APA's analysis as a way to examine if the SOQ models take the need of a district into account; they are not meant to be a recommendation of how Virginia should allocate resources. Applying these weights, the range in the ratio of weighted to unweighted students among the school divisions is 1.12 to 1.40.

Using the information provided to APA by VDOE, APA began to analyze the relationships between actual division staffing and staff allocations through the SOQ, and division factors such as size and student need.

Variations in Allotted and Actual Personnel across School Divisions

The figures in Tables 2A and 2B provide some basic statewide information for 23 types of personnel (14 instructional and 9 support categories) in three areas:

1. Personnel actually employed in that category per 1,000 students;
2. Personnel allotted by SOQ ratios per 1,000 students; and
3. The ratio of actual to SOQ allotted figures (actual staffing divided by SOQ allocation).

The basic information provided includes: (1) the statewide average; (2) the standard deviation of the distribution of school divisions; (3) the coefficient of variation; (4) the correlation between numbers of personnel and the size (enrollment) of all school divisions; and (5) the correlation between numbers of personnel and the relative needs of all school divisions. What each of these figures means is explained in further detail below:

1. *The statewide average,* which is the simple average across all school divisions, expressed as personnel per 1,000 students as discussed previously. This figure is not weighted by district enrollment so it cannot be used to estimate statewide costs.

2. *The standard deviation*, which is an indicator of variation. Nearly seventy percent of all data points will be within plus or minus one standard deviation from the mean, with ninety-five percent being within plus or minus two standard deviations. Therefore, a larger standard deviation figure indicates that division figures are more spread out from the mean, while a smaller standard deviation figure means that they are more closely gathered around the mean. However, for the purposes of this study, this figure is not of much use by itself, so instead we use this figure to calculate the coefficient of variation, which is a better indicator of variation because it can be used to compare across SOQs.

3. *The coefficient of variation,* which is the standard deviation divided by the average. This figure indicates the extent to which the figures for divisions differ from one another. Figures above .20 suggest quite a bit of variation because it means that a third of all divisions have figures that might be either more than 20 percent higher than the average or more than 20 percent lower than the average.

4. *Correlation with division size,* which shows if there is a relationship between the numbers of personnel and the size (enrollment) of all school divisions. Figures below .300 are thought of as being a "weak" relationship. It is also worth noting if the correlation is positive or negative. In this case, a positive correlation would indicate that as the size of the division grew, so did the number of personnel they employ per 1,000 students, while a negative figure would indicate that as division size grew, the number of personnel per 1,000 tends to decrease.

5. *Correlation with student need,* which shows if there is a relationship between the numbers of personnel and the relative needs of all school divisions. As mentioned in an earlier section, this relative need factor is the ratio of weighted to unweighted students. Students are assigned a weight based on their special needs (being economically disadvantaged, an English Language Learner, or being in special education) to reflect the additional resources divisions typically employ to meet these student needs. As with the size correlation figures, a relationship below .300 is considered weak, and the sign [+ or -] demonstrates whether the relationship is positive or negative.

To more clearly illustrate how these figures are used, we can use Elementary Teachers, the first personnel category in Table 2A, as an example. There are three rows of information for elementary teachers: (1) the number of elementary teachers that are actually employed in all of the divisions, (2) the number of elementary teachers allocated to divisions based on SOQs, and (3) the ratio of actual teachers to allocated teachers. Looking at the first row, actual elementary teachers employed, the first column of data shows the average number of teachers per 1,000 students, which is 80.62. The second column of data is the standard deviation, which is 12.78. This means that nearly seventy percent of divisions employ between 67.8 (80.62 – 12.78 or one standard deviation) and 93.4 (80.62 + 12.78 or one standard deviation) teachers per 1,000 students, and ninety-five percent employ between 55.1 (80.62 – 15.56 or two standard deviations) and 106.2 (80.62 + 15.56 or two standard deviations) teachers per 1,000 students. The third column of data shows the coefficient of variation, which puts the variation

between division figures in a better perspective. In this case, that figure is .16; while the standard deviation may seem to indicate a wide variation from the mean, the coefficient of variation is actually fairly low, so it is not an area for concern. The final two columns of data show the correlation with division size and with student need. The correlation figure for size is -.199, which indicates a slight negative relationship between division size and number of teachers per 1,000. This is not unusual, since small schools tend to have lower teacher to student ratios than larger schools. However, since this figure is less than +/-.300, it is still a weak relationship. The correlation figure for student need, on the other hand, is above .300 at .331 so it indicates that there is a moderately positive relationship between student need and number of teachers employed, meaning the higher the relative need is in a school district, the more teachers that they employ.

It is worth noting that a few types of personnel account for a large portion of all the personnel actually employed in school divisions. The total number of people actually employed in the 23 types of personnel we examined was 160,648, based on data from the 2007-2008 Annual School Report as provided by the department. Of these, 124,226 were instructional staff and 36,422 were support staff. Among instructional staff, elementary and secondary teachers account for 75.3 percent of all staff actually employed; adding elementary and secondary teacher aides to this teacher total account for 90.5 percent of all instructional staff (so four of the 14 types of instructional personnel represent 90 percent of all instructional staff). Similarly, school-based clerical and technical clerical personnel account for 75.7 percent of all support staff. The fact is that six types of personnel (elementary and secondary teachers and aides plus school-based and technical clerical workers – or six out of 23 types of personnel) account for 87 percent (or about five out of every six) employees.

Table 2A
Instructional Staff per 1,000, Comparison between Actual Staffing and SOQ
Descriptive Statistics

Position	Average	Standard Deviation	Coefficient of Variation	Correlation with Division Size	Correlation with Student Need
Elementary Teachers Actual per 1,000	80.62	12.78	0.16	-0.199	0.331
Elementary Teachers SOQ per 1,000	69.94	7.12	0.10	-0.180	0.188
Elementary Teacher Ratio	*1.16*	*0.18*	*0.16*	*-0.097*	*0.219*
Secondary Teachers Actual per 1,000	88.48	17.18	0.19	-0.120	0.289
Secondary Teachers SOQ per 1,000	76.41	9.61	0.13	-0.226	0.229
Secondary Teacher Ratio	*1.17*	*0.22*	*0.19*	*0.018*	*0.154*
Elementary Teacher Aides Actual per 1000	23.19	8.75	0.38	-0.211	0.041
Elementary Teacher Aides SOQ per 1000	2.63	1.30	0.49	-0.074	0.002
Elementary Teacher Aides Ratio	*10.46*	*7.34*	*0.70*	*-0.114*	*0.023*
Secondary Teacher Aides per 1000 Actual	11.20	6.48	0.58	-0.070	0.069
Secondary Teacher Aides per 1000 SOQ	2.02	1.09	0.54	-0.035	0.136
Secondary Teacher Aides Ratio	*6.71*	*5.98*	*0.89*	*-0.064*	*0.003*
Elementary Guidance Actual per 1,000	2.49	0.87	0.35	-0.049	0.218
Elementary Guidance SOQ per 1,000	1.60	0.21	0.13	-0.030	0.010
Elementary Guidance Ratio	*1.57*	*0.55*	*0.35*	*-0.048*	*0.195*
Secondary Guidance Actual per 1,000	4.11	1.46	0.35	0.129	0.233
Secondary Guidance SOQ per 1,000	3.93	1.18	0.30	-0.023	-0.235
Secondary Guidance Ratio	*1.09*	*0.40*	*0.37*	*0.107*	*0.284*
Elementary Librarian Actual per 1,000	2.18	1.07	0.49	-0.165	0.156
Elementary Librarian SOQ per 1,000	1.70	0.43	0.26	-0.241	0.110
Elementary Librarian Ratio	*1.29*	*0.50*	*0.39*	*-0.055*	*0.120*
Secondary Librarian Actual per 1,000	1.67	0.87	0.52	-0.082	0.153
Secondary Librarian SOQ per 1,000	2.52	1.24	0.49	-0.214	-0.145
Secondary Librarian Ratio	*0.71*	*0.34*	*0.48*	*0.092*	*0.145*
Elementary Principal Actual per 1,000	2.43	0.95	0.39	-0.275	0.216
Elementary Principal SOQ per 1,000	1.70	0.43	0.26	-0.241	0.110
Elementary Principal Ratio	*1.42*	*0.37*	*0.26*	*-0.212*	*0.221*
Secondary Principal Actual per 1,000	1.96	1.23	0.63	-0.280	0.152
Secondary Principal SOQ per 1,000	2.49	2.06	0.83	-0.241	-0.104
Secondary Principal Ratio	*0.85*	*0.30*	*0.36*	*0.025*	*0.234*
Elementary Asst. Principal Actual per 1,000	1.41	0.89	0.64	0.128	0.059
Elementary Asst. Principal SOQ per 1,000	0.14	0.20	1.44	0.230	-0.103
Elementary Asst. Principal Ratio	*6.69*	*4.59*	*0.69*	*0.008*	*0.168*
Secondary Asst. Principal Actual per 1,000	2.61	0.98	0.37	0.049	0.115
Secondary Asst. Principal SOQ per 1,000	1.14	0.76	0.67	0.295	-0.230
Secondary Asst. Principal Ratio	*1.92*	*0.85*	*0.44*	*-0.140*	*0.299*
Elementary Tech Teacher Actual per 1,000	1.09	1.14	1.05	0.070	0.001
Elementary Tech Teacher SOQ per 1,000	1.02	0.06	0.05	0.005	-0.387
Elementary Tech Teacher Ratio	*1.07*	*1.13*	*1.06*	*0.067*	*0.027*
Secondary Tech Teacher Actual per 1,000	1.45	1.69	1.16	0.017	0.045
Secondary Tech Teacher SOQ per 1,000	1.07	0.21	0.19	-0.043	-0.259
Secondary Tech Teacher Ratio	*1.38*	*1.60*	*1.16*	*0.015*	*0.059*

Table 2B
Support Staff per 1,000, Comparison between Actual Staffing and SOQ
Descriptive Statistics

Position	Average	Standard Deviation	Coefficient of Variation	Correlation with Division Size	Correlation with Student Need
Instructional Professional Actual per 1,000	3.02	2.22	0.73	0.013	0.179
Instructional Professional SOQ per 1,000	2.97	0.07	0.02	-0.067	-0.121
Instructional Professional Ratio	*1.02*	*0.75*	*0.74*	*0.015*	*0.181*
General O&M Actual per 1,000	0.29	0.25	0.86	0.017	0.193
General O&M SOQ per 1,000	0.35	0.01	0.02	-0.063	-0.155
General O&M Ratio	*0.85*	*0.73*	*0.86*	*0.018*	*0.191*
Technical Support Actual per 1,000	1.83	1.06	0.58	0.029	0.019
Technical Support SOQ per 1,000	1.53	0.04	0.02	-0.067	-0.123
Technical Support Ratio	*1.20*	*0.70*	*0.58*	*0.031*	*0.023*
School Based Clerical Actual per 1,000	4.88	1.73	0.35	0.108	0.199
School Based Clerical SOQ per 1,000	5.07	0.12	0.02	-0.111	-0.128
School Based Clerical Ratio	*0.96*	*0.34*	*0.36*	*0.116*	*0.203*
Technical Clerical Actual per 1,000	14.26	4.40	0.31	0.106	0.337
Technical Clerical SOQ per 1,000	15.16	0.37	0.02	-0.067	-0.124
Technical Clerical Ratio	*0.94*	*0.29*	*0.31*	*0.110*	*0.341*
Instructional Technical Actual per 1,000	2.62	1.94	0.74	0.041	0.091
Instructional Technical SOQ per 1,000	2.61	0.06	0.02	-0.068	-0.125
Instructional Technical Clerical Ratio	*1.01*	*0.75*	*0.74*	*0.042*	*0.093*
General Administration Actual per 1,000	0.73	0.78	1.07	0.064	0.217
General Administration SOQ per 1,000	0.81	0.02	0.02	-0.071	-0.116
General Administration Ratio	*0.89*	*0.96*	*1.07*	*0.064*	*0.216*
Attendance and Health Administration Actual per 1,000	1.17	0.79	0.67	0.040	0.027
Attendance and Health Administration SOQ per 1,000	1.38	0.03	0.02	-0.067	-0.127
Attendance and Health Administration Ratio	*0.85*	*0.57*	*0.67*	*0.043*	*0.031*
Assistant Superintendent Acutal per 1,000	0.15	0.20	1.32	-0.093	-0.080
Assistant Superintendent SOQ per 1,000	0.24	0.01	0.03	-0.081	-0.102
Assistant Superintendent Ratio	*0.64*	*0.84*	*1.32*	*-0.093*	*-0.080*

Our expectations were that we would find: (1) a difference between the actual number of personnel per 1,000 students and the number of personnel allotted by each SOQ ratio (and that such differences would be such that the ratio of actual-to-allotted personnel would be greater than 1.00; not much variation in the number of personnel per 1,000 students allotted by an SOQ ratio; (2) if there were much variation in the number of personnel per 1,000 students allotted by an SOQ ratio, that variation might be associated with district size and/or district need; and (3) if there were much variation in the actual number of personnel per 1,000 students, it would be related to the needs of school divisions. While we had hoped to examine the relationship between numbers of personnel and student performance, we found it very difficult to create a measure of student performance at the school division level that made sense. The state does not have such a measure and there are at least three ways that one might be created when there is agreement on the objective (including achievement test scores, student attendance, and graduation rates): based on absolute levels of student performance, change in student performance, and comparison of actual to expected performance based on student demographic characteristics.

There are a variety of issues worth noting about the figures shown in Tables 2A and 2B (Table 2A shows data for instructional personnel while Table 2B addresses support personnel). First, in 10 of the 14 types of instructional personnel, the average number of personnel actually employed is at least 10 percent *higher* than the average number of personnel allotted by an SOQ, as shown by the "ratio" row for those types of personnel being greater than 1.10 (shown under the "average" column); that is, for those types of personnel, school divisions tend to employ more people than they earn under the SOQ ratio. This includes the four categories of personnel that account for the vast majority of instructional personnel (as mentioned above). Again, this may be because the Annual School Report captures positions that are funded both within and outside of the SOQ and captures positions that are funded from state, federal, and local sources of funds, whether related to the SOQ or not.

At the same time, in four of the nine support personnel categories, the average number of personnel actually employed is at least 10 percent *lower* than the average number of personnel allotted by an SOQ. This can be seen where the "ratio" row for those types of personnel is less than .90 (shown under the "average" column). This is not the case for the two types of personnel that account for a large portion of all support staff (for which the average number employed is very close to the average number allotted). This suggests that school divisions tend to need more instructional staff than are provided under the SOQ ratios and that they are willing to trade off between support staff and instructional staff.

Second, in nine of the 14 types of instructional personnel categories (Table 2A), there is a high level of variation in the number of personnel per 1,000 students allotted by an SOQ (because the coefficient of variation was greater than .20) while at the same time the correlation between the number of personnel allotted by an SOQ and both school division size and school division need is weak (the correlation is between -.300 and +.300), therefore not explaining the variation that exists. This may be because some of the SOQs are school-based and are specified with "cliffs" under which schools in one size range are eligible to receive one level of personnel while schools in a different size range are eligible to receive a different level of personnel, resulting in dramatically different numbers of personnel per 1,000 students. When considering the coefficient of variation for these nine instructional personnel categories, in four cases the variation in actual personnel per 1,000 students is less than in the variation in the SOQ personnel per 1,000 students (three of which are administrator positions). Then, when looking at the correlation with student need, there are five instances where the correlation between actual personnel per 1,000 students and student need switches from being negative to being positive (although still weak) in comparison to the SOQ personnel per 1,000 students.

Third, the numbers of all types of support staff allotted under the SOQ ratios are very similar across school divisions (with coefficients of variation at or under .03), which reflects the fact that most of those SOQs are defined in terms of personnel per 1,000 students. Unfortunately, there is almost no relationship between numbers of support staff allotted under the SOQ ratios and the needs of school districts (in fact, while the relationships are weak, they are all negative); but the numbers of support staff actually employed are positively related to district needs (even if the relationships are still weak).

The figures in Tables 3 and 4 illustrate the relationships between numbers of personnel and school division size (Table 3) and need (Table 4) for the six instructional and support types of personnel that,

taken together, represent over 90 percent of all personnel actually employed by school divisions. To illustrate these relationships, divisions are divided into five groups, or quintiles, so that differences in the averages of these groups could be examined. We use this procedure to see whether patterns exist even though correlations might be low. In Table 4, that meant that divisions were divided into quintiles by their size, with the 1st quintile being the 20 percent of divisions that are the smallest, up to the fifth quintile, which is the 20 percent of divisions that are the largest. The divisions were then similarly divided into quintiles based upon their student need, with the 1st quintile being the divisions that had the lowest need, and the 5th quintile being the divisions with the highest need (need being the weighted to unweighted student ratio described previously). Divisions could just have easily been divided into four groups, or ten groups; in this case, APA chose quintiles because it split the divisions into enough different groups to allow for meaningful comparison without making patterns difficult to see by having too many groups. This is standard practice undertaken in other studies.

Table 3
Instructional and Support Staff per 1,000, Comparison between Actual Staffing and SOQ
By Division Size Quintiles

	Division Size				
	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile
Position	1,682 or Less	1,683-2,627	2,628-4,586	4,586-10,598	Greater than 10,598
Elementary Teachers Actual per 1,000	89.57	79.49	81.23	78.86	74.06
Elementary Teachers SOQ per 1,000	76.17	69.89	69.26	67.70	66.79
Elementary Teacher Ratio	*1.19*	*1.14*	*1.18*	*1.17*	*1.11*
Secondary Teachers Actual per 1,000	93.83	89.01	87.00	85.29	87.55
Secondary Teachers SOQ per 1,000	83.74	75.65	75.69	75.69	71.60
Secondary Teacher Ratio	*1.13*	*1.18*	*1.15*	*1.14*	*1.22*
Elementary Teacher Aides per 1000 Actual	26.15	23.96	24.44	22.17	19.25
Elementary Teacher Aides per 1000 SOQ	3.02	2.45	2.69	2.47	2.55
Elementary Teacher Aides Ratio	*12.81*	*11.76*	*10.14*	*9.82*	*8.55*
Secondary Teacher Aides per 1000 Actual	13.33	11.71	11.06	10.35	11.53
Secondary Teacher Aides per 1000 SOQ	2.53	2.07	2.01	1.99	1.94
Secondary Teacher Aides Ratio	*6.08*	*7.37*	*6.91*	*7.24*	*6.87*
School Based Clerical Actual per 1,000	4.82	5.54	4.23	4.96	4.83
School Based Clerical SOQ per 1,000	5.06	5.04	5.12	5.06	5.07
School Based Clerical Ratio	*0.95*	*1.10*	*0.83*	*0.98*	*0.95*
Technical Clerical Actual per 1,000	15.34	12.88	14.05	13.90	15.19
Technical Clerical SOQ per 1,000	15.32	15.09	15.10	15.18	15.12
Technical Clerical Ratio	*1.01*	*0.85*	*0.93*	*0.92*	*1.00*

Table 4
Instructional and Support Staff per 1,000, Comparison between Actual Staffing and SOQ
By Student Need Quintiles

Position	Student Need (Weighted to Unweighted Student Ratio)				
	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile
	1.200 or Less	1.201-1.240	1.241-1.270	1.271-1.304	Greater than 1.304
Elementary Teachers Actual per 1,000	74.53	76.13	87.80	81.75	85.46
Elementary Teachers SOQ per 1,000	67.66	69.39	71.40	69.55	72.21
Elementary Teacher Ratio	*1.10*	*1.10*	*1.24*	*1.18*	*1.19*
Secondary Teachers Actual per 1,000	85.35	84.59	87.79	87.78	97.77
Secondary Teachers SOQ per 1,000	71.80	76.78	79.81	76.03	78.21
Secondary Teacher Ratio	*1.19*	*1.11*	*1.10*	*1.16*	*1.26*
Elementary Teacher Aides per 1000 Actual	21.77	23.01	26.35	22.20	22.94
Elementary Teacher Aides per 1000 SOQ	2.53	3.09	2.29	2.14	2.92
Elementary Teacher Aides Ratio	*10.67*	*9.10*	*11.63*	*13.67*	*8.79*
Secondary Teacher Aides per 1000 Actual	10.41	12.33	12.54	10.27	11.94
Secondary Teacher Aides per 1000 SOQ	1.90	2.02	2.16	1.99	2.43
Secondary Teacher Aides Ratio	*6.50*	*7.30*	*8.23*	*6.77*	*5.91*
School Based Clerical Actual per 1,000	4.81	4.42	5.46	4.86	4.99
School Based Clerical SOQ per 1,000	5.06	5.06	5.06	5.05	5.12
School Based Clerical Ratio	*0.95*	*0.88*	*1.08*	*0.96*	*0.98*
Technical Clerical Actual per 1,000	12.45	13.38	15.21	13.17	17.39
Technical Clerical SOQ per 1,000	15.25	15.14	15.13	15.10	15.17
Technical Clerical Ratio	*0.82*	*0.88*	*1.01*	*0.87*	*1.15*

Tables 3 and 4 show the relationships between staffing and division size and need by examining how the average number of employees per 1,000 students (actually employed, SOQ-allotted, and the ratio of actually employed to SOQ-allotted) changes across quintiles of school divisions based on size and need (quintiles are ranked from low to high moving from left to right). The Elementary Teachers personnel category can again be used as an example to demonstrate what is being shown in Tables 3 and 4. Looking at Table 3 and the line for Elementary Teachers allocated by SOQ, it can be seen that teacher allocations vary somewhat by size. For the 1st quintile, which is made up of districts that have 1,682 students or less, the average SOQ allocation is 76.17 teachers per 1,000. This average decreases as division size increases, going from 69.89 in the 2nd quintile, to 69.26 in the 3rd, 67.70 in the 4th, and 66.79 in the 5th quintile.

In regard to Table 3, it is clear that SOQ-allotted teachers are sensitive to division enrollment. This is evidenced by the fact that the number of teachers per 1,000 declines as the size of the divisions grow. This relationship also exists for secondary teacher aides per the SOQ. The relationship between division

size and actual number of elementary teachers is somewhat stronger than is true for SOQ-allotted elementary teachers although that is not the case for secondary teachers. Essentially, numbers of support staff (of the two types shown) are unrelated to division size when looking at the SOQ allocations which remain consistent across quintiles and there is no discernable pattern when looking at actual support staffing. Looking at Table 4, while there is a small relationship between SOQ-allotted elementary and secondary teachers and division needs (that is, the highest need divisions [those in the fifth quintile] earn more teachers than the lowest need divisions [those in the first quintile] but the pattern does not hold true for divisions with moderate levels of need [the three middle quintiles]). The relationship is stronger for actual teachers employed, which, along with the fact that the ratios of actual to SOQ-allotted teachers are higher in the fifth quintile than they are in the first quintile, suggests that school division actual staffing is more sensitive to need than the SOQ ratios are. Again, this may not be unexpected because of the actual staffing as shown in this study is derived from the Annual School Report and covers programs that can fall outside of the SOQ.

Ideas for the Virginia Board of Education's Consideration

On the basis of APA's analyses, a few key points about the Standards of Quality can be highlighted for the Board's consideration.

1. School divisions employ more personnel than the SOQ ratios provide. It appears that the majority of Virginia school divisions employ personnel at a higher level than currently prescribed in the SOQ, validating the concept that the SOQ is intended to be a minimum education foundation program.

    - It is important to remember that the SOQ ratios do not include all the personnel a district would be expected to employ. An example would be elementary aides where the SOQ ratio only includes aides for kindergarten and special education. Most districts employ aides for other purposes. This may be why the SOQ figure is much lower than the actual figure for this category of personnel.

    - The majority of the personnel categories with higher personnel were in the instructional categories. For the time period examined, the average numbers of personnel actually employed were higher than the SOQ ratios. Given that the Annual School Report captures all positions employed within school division not just those related to the SOQ, this is not unexpected.

    - The average number of elementary teachers is 16 percent above the SOQ ratio. Elementary teachers make up 34 percent of all personnel examined.

- The average number of secondary teachers is 17 percent above the SOQ ratio. Secondary teachers make up 24 percent of all personnel examined.

- The numbers of elementary and secondary teachers actually employed by districts appear to be related to district needs based on examining quintiles of school divisions organized by need.

2. It appears that school divisions are using their support category revenue to employ more instructional personnel. This strategy is permissible because prevailing support dollars may be used for instructional needs.

3. One personnel category that may need to be examined is nurses assuming that a shift in funding formulas does not detrimentally affect school divisions.

    - The states with which we talked mentioned nurses as a personnel group for which they are considering setting a new standard or revising an existing one.

    - APA believes that a ratio of 750 students per nurse might be appropriate. Currently, school divisions in Virginia provide nursing services but there is no mandated staffing standard.

4. All SOQ ratios could be expressed in personnel per 1,000 student terms, assuming that such a shift does not detrimentally affect funding or staffing and class sizes at the school and classroom levels. Some factors to consider are:

    - Currently the state uses both student personnel ratios and personnel per 1,000 terms to express SOQ ratios. Using one approach will simplify the SOQ process.

    - Such an approach would avoid the “cliffs” built into some current SOQ ratios. These cliffs are based on break points related to school size that make assumptions about how schools are staffed that may not be true.

    - In APA’s examination of the data the instructional categories that use this cliff style funding had far more variation in personnel per 1,000 students than other categories.

    - The cliffs mean a school with a difference of just one student can be funded very differently. For example, a school with one more student than another school earns an additional half-time principal for that student.

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Appendix C: Chart of Possible Action Items and Issues for Further Action

Standards of Quality (SOQ) Review and Options for Discussion – 2009 Study
DRAFT - SEPTEMBER 17, 2009

POSSIBLE ACTION ITEMS

The considerations below are intended to maintain quality standards for public education, recognizing when revenues are limited divisions will need greater flexibility in allocating funds to meet the specific needs of diverse student populations. The options for consideration also pull into the SOQ certain educational programs that are essential to a "quality education" and in the Appropriation Act only. This action will enhance the SOQ and provide greater transparency in the allocation of public funds.

SOQ Issues for Examination	Possible Action Item	Background Information and Next Steps
2008 Flexibility Options – Incorporate the Board's recommendations on data coordinators, reading specialists, mathematics specialists, and English Language Learner teachers from 2008 and funded in the Appropriation Act into the SOQ. The SOQ survey collects information on the use of specialists for reading, mathematics, and English language learners (ELL).	Put language currently in the Appropriation Act into Standard 2. Currently, The flexibility options cover: 1) data coordinators and instructional technology resource teachers (ITRTs); 2) reading specialists and the Early Intervention Reading Intervention Initiative (EIRI) funds; 3) mathematics specialists and the Algebra Readiness Initiative (ARI) funds; 4) English Language Learner (ELL) teachers and SOQ prevention, intervention, and remediation funds.	The addition of the flexibility language would permanently establish the importance of these positions in state law and provide a long-term flexibility option for school divisions. A common theme in the SOQ survey data is the need for local flexibility. **Next Steps:** Add flexibility language currently in the Appropriation Act in the *Code of Virginia* in Standard 2 as this will ensure that school divisions continue to have flexibility to spend funds according to the area of greatest need. Over 96 percent of school divisions responding to the SOQ survey indicated that reading specialists will be employed for the 2009-2010 school year.

SOQ Issues for Examination	Possible Action Item	Background Information and Next Steps
Movement of Other Programs into the SOQ – The issue of moving programs such as the Early Intervention Reading Initiative (EIRI), the Algebra Readiness Initiative (ARI), the Individual Student Alternative Education Plan (ISAEP), and possibly other programs into the SOQ needs to be examined.	Move EIRI and ARI from Lottery funded accounts into the SOQ. **Other Issues for Consideration:** 1) Should the EIRI and ARI program requirements be set out in the SOQ as separate standards, as is currently done for ELL? 2) Should other programs outside of the SOQ, such as the ISAEP program, be moved within the SOQ?	The EIRI and ARI programs directly support SOQ efforts in the areas of reading and mathematics. Moving these programs into the SOQ further strengthens the foundation program for K-12 education. This action reduces administrative burden on school divisions because there would no longer be a certification process related to certain accounts outside of the SOQ. This action would convert programs that are now optional but carrying almost a 100 percent school division participation rate to SOQ entitlements. Note: This option would change the funding mix between general fund and Lottery accounts. Required local effort for school divisions needs to be considered as well. **Next Steps:** Add EIRI and ARI program requirements and funding to Standard 1. Preliminary estimates of the impact on SOQ funding will need to be calculated as well as the funding mix between the General Fund and the Lottery Proceeds Fund.
Assistant Principal – Provide flexibility in assigning "school leaders" to individual buildings. Current staffing ratio:	Provide school divisions the flexibility to deploy assistant principals to the schools with the greatest needs, so long as they employ a sufficient number of assistant principals divisionwide to meet the total	This option would give additional flexibility to local school divisions in how personnel are assigned but would not change the current funding standard for assistant principals. This option would

SOQ Issues for Examination	Possible Action Item	Background Information and Next Steps
– Assistant principals are funded in the following manner: 1) in elementary schools - one half-time at 600 students, one full-time at 900 students; 2) in middle schools - one full-time for each 600 students; 3) in high school schools - one full-time for each 600 students.	number required in the current SOQ staffing requirement.	ensure that assistant principal staffing could be targeted according to need. **Next Steps:** Draft language in Standard 2 that would permit flexibility but not affect the existing staffing standard for assistant principals. This would be another option for allocation, like those related to reading specialists and mathematics specialists.
Basic Operation Cost (58:1,000 ratio) – The language in the Appropriation Act related to this standard (see attachment) could become part of Standard 2 in the *Code*, with the positions related to gifted, career and technical education (CTE), and special education set out as separate standards.	Adapt Appropriation Act language to Standard 2.	Putting this language in Standard 2 would clarify this arrangement and tie basic standards directly back to the *Code of Virginia* and house all SOQ items in one place in the law. It would also clearly delineate within the SOQ the minimum foundation program for K-12 education. **Next Steps:** Insert Appropriation Act language into Standard 2 and make any needed modifications.

SOQ Issues for Examination	Possible Action Item	Background Information and Next Steps
Administrative Support Categories – Should the current positions within the administrative support category be further defined and categorized in the SOQ. Positions affected would include administrative personnel, attendance and health, pupil transportation, operation and maintenance, facilities, technology, and school-based support positions.	The types of support positions could be set out in the SOQ. Furthermore, the Standard 2 could be modified to state that funding provided for support positions can be used to support instructional services. Define the categories of personnel who make up "support services," specify how those positions are funded, and require transparency in the use of funds by mandating divisions publicly report the state and local amounts budgeted and expended for each category. Permit school divisions to use funds for support services to provide additional instructional services and include instructional services as a separate category to be reported publicly.	Reporting the types and funding for each administrative position makes the SOQ clearer and easier to understand. Language in the SOQ providing flexibility for school divisions to use support funding for instruction would memorialize current practice. **Next Steps:** Insert draft language into Standard 2 that clarifies categories of administrative support services, specifies how these positions are funded and requires public reporting of funds budgeted and expended for each category. Insert flexibility language into Standard 2.

SOQ Issues for Examination	Possible Action Item	Background Information and Next Steps
Special Education – The staffing ratios used for funding special education are referenced in the Appropriation Act and outlined in regulations.	Insert special education ratios in the SOQ so that the standards are formally recognized in the *Code*.	Currently, staffing ratios for special education exist in regulations and are funded in the SOQ because of language in the Appropriation Act. Including the staffing standards in Standard 2 would clarify this arrangement and tie special education staffing directly back to the SOQ. **Next Steps:** Insert staffing ratios in the Standard 2.
Career and Technical Education (CTE) Staffing – The Board's CTE regulations include staffing ratios, but they do not appear in the SOQ.	Move the current CTE staffing ratios into the SOQ.	Currently, staffing ratios for CTE exist in regulations and are funded in the SOQ because of language in the Appropriation Act. **Next Steps:** Insert staffing ratios in the Standard 2.

Standards of Quality (SOQ) Review and Options for Discussion – 2009 Study
DRAFT - SEPTEMBER 17, 2009

POTENTIAL POLICY DIRECTIVES FOR FURTHER ACTION IN 2010

The considerations below are intended to maintain quality standards for public education, recognizing when revenues are limited divisions will need greater flexibility in allocating funds to meet the specific needs of diverse student populations. The options for consideration also pull into the SOQ certain educational programs that are essential to a "quality education" and in the Appropriation Act only. This action will enhance the SOQ and provide greater transparency in the allocation of public funds. These considerations also suggest key issues where the Board may want to authorize further study, with a report next year pending the availability of resources.

SOQ Issues for Examination	Issue for Further Action in 2010	Background Information and Next Steps
Principal/Assistant Principal – Create staffing ratios to give superintendents flexibility in assigning "school leaders" to individual buildings given a total divisionwide allocation for school leaders (principals and assistant principals). The staffing ratio would take into account the goal of having a principal assigned to each building and additional assistants for schools with the greatest need. Current staffing ratios: – **Principals** are funded in the following manner: 1) in elementary schools - one half-time to 299 students, one full-time at 300 students; 2) in middle schools - one full-time, to be employed on a 12-month basis; 3) in high schools - one full-time, to be employed on a 12-month basis **Assistant principals** are funded in the	Define a new funding formula that addresses the Board's school leadership priorities of requiring a principal in every school and increasing the number of assistant principals in schools with the greatest need.	Converting from a specific formula for principals and assistant principals to a "school leadership" umbrella would give additional flexibility to local school divisions in how personnel are assigned. This option would provide additional funding for elementary principals and assignments for assistant principals could be targeted according to need. The standard needs to be written in such a manner that small school divisions do not encounter compliance issues. Because this item involves a greater level of funding for school leaders in school divisions, it needs to be addressed in 2010 in conjunction with other staffing issues noted below.

SOQ Issues for Examination	Issue for Further Action in 2010	Background Information and Next Steps
following manner: 1) in elementary schools - one half-time at 600 students, one full-time at 900 students; 2) in middle schools - one full-time for each 600 students; 3) in high school schools - one full-time for each 600 students.		
Special Education – As response to intervention (RTI) is effectively implemented, more students are mainstreamed reducing a division's special education funding. The practice of mainstreaming creates a perverse funding incentive for school divisions and needs to be examined since effective RTI requires additional instructional support, such as that provided by reading and mathematics specialists. Are there any funding options available that could supplement school divisions so that dollars are not being lost due to the unintended funding consequences of RTI use? – The SOQ contains standards that are based on certain student populations, such as English language learners (ELL) but does not reference specific standards for students with disabilities.	Create a funding mechanism that would supplement the use of RTI by providing additional instructional support to help children receiving RTI continue to meet student achievement goals. Funds lost due to students being mainstreamed could be made available to divisions in a special "hold harmless" account to support additional instructional staff such as reading and mathematics specialists. To create this funding mechanism, further study is needed. The full effect of educating students with disabilities in the mainstream classroom coupled with the trends in the special education child count resulting from this intervention strategy needs further examination.	The Board has heard comments from school divisions that the use of RTI has the unintended consequence of actually lowering state funding for special education services because more students are being educated in the mainstream classroom. Funding could be provided to offset this unintended consequence and to provide resources for more instructional tools in those classrooms where RTI is being used. Further study is needed to determine how such funding should be allocated.

SOQ Issues for Examination	Issue for Further Action in 2010	Background Information and Next Steps
Administrative Support Categories – Should the current positions within the administrative support category be grouped into categories and possibly streamlined or divided amongst ratio-based funding and existing funding methodologies? The intent is to maintain quality support services while increasing emphasis on instructional support services.	The feasibility of establishing ratios for all or some categories of support positions needs further study as does the establishment of a methodology by which support costs are funded.	A study of this issue could result in the establishment of a standard that would staff specific support positions in line with how instructional staffing standards are presented. The standard needs to be written in such a manner that small school divisions do not encounter compliance issues. This is an issue that needs further study.
CTE Staffing Study – The Board's CTE regulations and staffing ratios need to be updated. Before this takes place, a study may be needed to examine class size ratios.	With the establishment of the technical diplomas in the SOQ and increased emphasis on high-tech industry certification programs, the examination of these regulations is timely. Furthermore, the proliferation of STEM academies, changes to the Perkins Act, the addition of economics and personal finance as a graduation requirement, and trends in technology further add to the justification that an independent study be undertaken.	A study of this issue will ensure that any changes to the staff ratios reflect the needs for school divisions and those of industry. This is an issue that needs further study.

SOQ Issues for Examination	Issue for Further Action in 2010	Background Information and Next Steps
Alternative Staffing Approaches – This issue examines the feasibility of converting each major category of the "support services" positions into ratios (for example, a certain number of positions per 1,000 students). Also, the feasibility of establishing ratios based on per-pupil weights to provide school divisions with additional instructional resources to address identified needs is an issue for further examination.	This analysis could include ratios for assistant principals, school counselors, and library-media specialists that would reduce funding "cliffs." It could also include assigning weights for students who may be at-risk and require additional support, including special education services, services to English language learners, and services to disadvantaged students.	A study of this issue will ensure that the staffing needs related to specific student populations are examined in accordance with all school division personnel needs. This is an issue that needs further study.
Technology Standard Study – The technology support standard in the SOQ (one position per 1,000 students) was first funded by the 2004 General Assembly.	The feasibility of updating technology staffing ratios needs to be examined, taking into consideration the increased role of technology in instruction, assessment, and operations since staffing standards were first established in the SOQ.	A study should take into account the technology support positions that are being funded via the administrative support funds. The establishment of the STEM academies, the General Assembly interest in electronic textbooks and instructional materials, and general trends in technology also need to be considered.

Appendix D: Proposed Legislation

Amending the Standards of Quality (SOQ)

Code of Virginia – Standards of Quality

§ 22.1-253.13:1. Standard 1. Instructional programs supporting the Standards of Learning and other educational objectives.

A. The fundamental goal of the public schools of this Commonwealth must be to enable each student to develop the skills that are necessary for success in school, preparation for life, and reaching their full potential. The General Assembly and the Board of Education fund that the quality of education is dependent upon the provision of (i) the appropriate working environment, benefits, and salaries necessary to ensure the availability of high-quality instructional personnel; (ii) the appropriate learning environment designed to promote student achievement; (iii) quality instruction that enables each student to become a productive and educated citizen of Virginia and the United States of America; and (iv) the adequate commitment of other resources. In keeping with this goal, the General Assembly shall provide for the support of public education as set forth in Article VIII, Section 1 of the Constitution of Virginia.

B. The Board of Education shall establish educational objectives known as the Standards of Learning, which shall form the core of Virginia's educational program, and other educational objectives, which together are designed to ensure the development of the skills that are necessary for success in school and for preparation for life in the years beyond. At a minimum, the Board shall establish Standards of Learning for English, mathematics, science, and history and social science. The Standards of Learning shall not be construed to be regulations as defined in § 2.2-4001.

The Board shall seek to ensure that the Standards of Learning are consistent with a high-quality foundation educational program. The Standards of Learning shall include, but not be limited to, the basic skills of communication (listening, speaking, reading, and writing); computation and critical reasoning including problem solving and decision making; proficiency in the use of computers and related technology; and the skills to manage personal finances and to make sound financial decisions.

The English Standards of Learning for reading in kindergarten through grade three shall be based on components of effective reading instruction, to include, at a minimum, phonemic awareness, phonics, fluency, vocabulary development, and text comprehension.

The Standards of Learning in all subject areas shall be subject to regular review and revision to maintain rigor and to reflect a balance between content knowledge and the application of knowledge in preparation for eventual employment and lifelong learning. The Board of Education shall establish a regular schedule, in a manner it deems appropriate, for the review, and revision as may be necessary, of the Standards of Learning in all subject areas. Such review of each subject area shall occur at least once

every seven years. Nothing in this section shall be construed to prohibit the Board from conducting such review and revision on a more frequent basis.

To provide appropriate opportunity for input from the general public, teachers, and local school boards, the Board of Education shall conduct public hearings prior to establishing revised Standards of Learning. Thirty days prior to conducting such hearings, the Board shall give notice of the date, time, and place of the hearings to all local school boards and any other persons requesting to be notified of the hearings and publish notice of its intention to revise the Standards of Learning in the Virginia Register of Regulations. Interested parties shall be given reasonable opportunity to be heard and present information prior to final adoption of any revisions of the Standards of Learning.

In addition, the Department of Education shall make available and maintain a website, either separately or through an existing website utilized by the Department of Education, enabling public elementary, middle, and high school educators to submit recommendations for improvements relating to the Standards of Learning, when under review by the Board according to its established schedule, and related assessments required by the Standards of Quality pursuant to this chapter. Such website shall facilitate the submission of recommendations by educators.

School boards shall implement the Standards of Learning or objectives specifically designed for their school divisions that are equivalent to or exceed the Board's requirements. Students shall be expected to achieve the educational objectives established by the school division at appropriate age or grade levels. The curriculum adopted by the local school division shall be aligned to the Standards of Learning.

The Board of Education shall include in the Standards of Learning for history and social science the study of contributions to society of diverse people. For the purposes of this subsection, "diverse" shall include consideration of disability, ethnicity, race, and gender.

With such funds as are made available for this purpose, the Board shall regularly review and revise the competencies for career and technical education programs to require the full integration of English, mathematics, science, and history and social science Standards of Learning. Career and technical education programs shall be aligned with industry and professional standard certifications, where they exist.

C. Local school boards shall develop and implement a program of instruction for grades K through 12 that is aligned to the Standards of Learning and meets or exceeds the requirements of the Board of Education. The program of instruction shall emphasize reading, writing, speaking, mathematical concepts and computations, proficiency in the use of computers and related technology, and scientific concepts and processes; essential skills and concepts of citizenship, including knowledge of Virginia history and world and United States history, economics, government, foreign languages, international cultures, health and physical education, environmental issues and geography necessary for responsible participation in American society and in the international community; fine arts, which may include, but need not be limited to, music and art, and practical arts; knowledge and skills needed to qualify for further education, gainful employment, or training in a career or technical field; and development of the ability to apply such skills and knowledge in preparation for eventual employment and lifelong learning and to achieve economic self-sufficiency.

Local school boards shall also develop and implement programs of prevention, intervention, or remediation for students who are educationally at risk including, but not limited to, those who fail to achieve a passing score on any Standards of Learning assessment in grades three through eight or who fail an end-of-course test required for the award of a verified unit of credit. Such programs shall include components that are research-based.

Any student who achieves a passing score on one or more, but not all, of the Standards of Learning assessments for the relevant grade level in grades three through eight may be required to attend a remediation program.

Any student who fails to achieve a passing score on all of the Standards of Learning assessments for the relevant grade level in grades three through eight or who fails an end-of-course test required for the award of a verified unit of credit shall be required to attend a remediation program or to participate in another form of remediation. Division superintendents shall require such students to take special programs of prevention, intervention, or remediation, which may include attendance in public summer school programs, in accordance with clause (ii) of subsection A of § 22.1-254 and § 22.1-254.01.

Remediation programs shall include, when applicable, a procedure for early identification of students who are at risk of failing the Standards of Learning assessments in grades three through eight or who fail an end-of-course test required for the award of a verified unit of credit. Such programs may also include summer school for all elementary and middle school grades and for all high school academic courses, as defined by regulations promulgated by the Board of Education, or other forms of remediation. Summer school remediation programs or other forms of remediation shall be chosen by the division superintendent to be appropriate to the academic needs of the student. Students who are required to attend such summer school programs or to participate in another form of remediation shall not be charged tuition by the school division.

The requirement for remediation may, however, be satisfied by the student's attendance in a program of prevention, intervention or remediation that has been selected by his parent, in consultation with the division superintendent or his designee, and is either (i) conducted by an accredited private school or (ii) a special program that has been determined to be comparable to the required public school remediation program by the division superintendent. The costs of such private school remediation program or other special remediation program shall be borne by the student's parent.

The Board of Education shall establish standards for full funding of summer remedial programs that shall include, but not be limited to, the minimum number of instructional hours or the equivalent thereof required for full funding and an assessment system designed to evaluate program effectiveness. Based on the number of students attending and the Commonwealth's share of the per pupil instructional costs, state funds shall be provided for the full cost of summer and other remediation programs as set forth in the appropriation act, provided such programs comply with such standards as shall be established by the Board, pursuant to § 22.1-199.2.

D. Local school boards shall also implement the following:

1. Programs in grades K through three that emphasize developmentally appropriate learning to enhance success.

2. Programs based on prevention, intervention, or remediation designed to increase the number of students who earn a high school diploma and to prevent students from dropping out of school. Such programs shall include components that are research-based.

3. Career and technical education programs incorporated into the K through 12 curricula that include:

a. Knowledge of careers and all types of employment opportunities including, but not limited to, apprenticeships, entrepreneurship and small business ownership, the military, and the teaching profession, and emphasize the advantages of completing school with marketable skills;

b. Career exploration opportunities in the middle school grades; and

c. Competency-based career and technical education programs that integrate academic outcomes, career guidance and job-seeking skills for all secondary students. Programs must be based upon labor market needs and student interest. Career guidance shall include counseling about available employment opportunities and placement services for students exiting school. Each school board shall develop and implement a plan to ensure compliance with the provisions of this subdivision. Such plan shall be developed with the input of area business and industry representatives and local community colleges and shall be submitted to the Superintendent of Public Instruction in accordance with the timelines established by federal law.

4. Educational objectives in middle and high school that emphasize economic education and financial literacy pursuant to § 22.1-200.03.

5. Early identification of students with disabilities and enrollment of such students in appropriate instructional programs consistent with state and federal law.

6. Early identification of gifted students and enrollment of such students in appropriately differentiated instructional programs.

7. Educational alternatives for students whose needs are not met in programs prescribed elsewhere in these standards. Such students shall be counted in average daily membership (ADM) in accordance with the regulations of the Board of Education.

8. Adult education programs for individuals functioning below the high school completion level. Such programs may be conducted by the school board as the primary agency or through a collaborative arrangement between the school board and other agencies.

9. A plan to make achievements for students who are educationally at risk a divisionwide priority that shall include procedures for measuring the progress of such students.

10. A plan to notify students and their parents of the availability of dual enrollment and advanced placement classes, the International Baccalaureate Program, and Academic Year Governor's School Programs, the qualifications for enrolling in such classes and programs, and the availability of financial assistance to low-income and needy students to take the advanced placement and International Baccalaureate examinations.

11. Identification of students with limited English proficiency and enrollment of such students in appropriate instructional programs.

12. Early identification, diagnosis, and assistance for students with reading and mathematics problems and provision of instructional strategies and reading and mathematics practices that benefit the development of reading and mathematics skills for all students.

Local school divisions shall provide early reading intervention services to students in grades kindergarten through 3 who demonstrate deficiencies based on their individual performance on any diagnostic test which has been approved by the Department of Education. School divisions shall report the results of the diagnostic tests to the Department of Education on an annual basis at a time to be determined by the Superintendent of Public Instruction. Each student who receives an intervention will be assessed again at the end of that school year. Such intervention programs, at the discretion of the local school division, may include, but not be limited to, the use of: special reading teachers; trained aides; volunteer tutors under the supervision of a certified teacher; computer-based reading tutorial programs; aides to instruct in-class groups while the teacher provides direct instruction to the students who need extra assistance; or extended instructional time in the school day or year for these students.

Local school divisions shall also provide mathematics intervention services to students in grades 6, 7, 8 and 9 who are at risk of failing the Algebra I end-of-course test, as demonstrated by their individual performance on any diagnostic test which has been approved by the Department of Education. School divisions shall report the results of the diagnostic tests to the Department of Education on an annual basis at a time to be determined by the Superintendent of Public Instruction. Each student who receives an intervention will be assessed again at the end of that school year.

13. Incorporation of art, music, and physical education as a part of the instructional program at the elementary school level.

14. A program of physical fitness available to all students with a goal of at least 150 minutes per week on average during the regular school year. Such program may include any combination of (i) physical education classes, (ii) extracurricular athletics, or (iii) other programs and physical activities deemed appropriate by the local school board. Each local school board shall incorporate into its local wellness policy a goal for the implementation of such program during the regular school year.

15. A program of student services for grades kindergarten through 12 that shall be designed to aid students in their educational, social, and career development.

16. The collection and analysis of data and the use of the results to evaluate and make decisions about the instructional program.

E. From such funds as may be appropriated or otherwise received for such purpose, there shall be established within the Department of Education a unit to (i) conduct evaluative studies; (ii) provide the resources and technical assistance to increase the capacity for school divisions to deliver quality instruction; and (iii) assist school divisions in implementing those programs and practices that will enhance pupil academic performance and improve family and community involvement in the public schools. Such

unit shall identify and analyze effective instructional programs and practices and professional development initiatives; evaluate the success of programs encouraging parental and family involvement; assess changes in student outcomes prompted by family involvement; and collect and disseminate among school divisions information regarding effective instructional programs and practices, initiatives promoting family and community involvement, and potential funding and support sources. Such unit may also provide resources supporting professional development for administrators and teachers. In providing such information, resources, and other services to school divisions, the unit shall give priority to those divisions demonstrating a less than 70 percent passing rate on the Standards of Learning assessments.

§ 22.1-253.13:2. Standard 2. Instructional, administrative, and support personnel.

A. The Board shall establish requirements for the licensing of teachers, principals, superintendents, and other professional personnel.

B. School boards shall employ licensed instructional personnel qualified in the relevant subject areas.

C. Each school board shall assign licensed instructional personnel in a manner that produces divisionwide ratios of students in average daily membership to full-time equivalent teaching positions, excluding special education teachers, principals, assistant principals, counselors, and librarians, that are not greater than the following ratios: (i) 24 to one in kindergarten with no class being larger than 29 students; if the average daily membership in any kindergarten class exceeds 24 pupils, a full-time teacher's aide shall be assigned to the class; (ii) 24 to one in grades one, two, and three with no class being larger than 30 students; (iii) 25 to one in grades four through six with no class being larger than 35 students; and (iv) 24 to one in English classes in grades six through 12.

~~*Within its regulations governing special education programs, the Board shall seek to set pupil/teacher ratios for pupils with mental retardation that do not exceed the pupil/teacher ratios for self-contained classes for pupils with specific learning disabilities.*~~

Further, school boards shall assign instructional personnel in a manner that produces schoolwide ratios of students in average daily memberships to full-time equivalent teaching positions of 21 to one in middle schools and high schools. School divisions shall provide all middle and high school teachers with one planning period per day or the equivalent, unencumbered of any teaching or supervisory duties.

D. *1.* Each local school board shall employ with state and local basic *aid*, special education, gifted, and career and technical education funds a minimum ~~*number*~~ of *58* licensed, full-time equivalent instructional personnel for each 1,000 students in average daily membership (ADM) as set forth in the appropriation act. Calculations of kindergarten positions shall be based on full-day kindergarten programs. Beginning with the March 31 report of average daily membership, those school divisions offering half-day kindergarten with pupil/teacher ratios that exceed 30 to one shall adjust their average daily membership for kindergarten to reflect 85 percent of the total kindergarten average daily memberships, as provided in the appropriation act.

2. Each local school board shall employ licensed, full-time equivalent positions in necessary to comply with the following requirements for special education services ***[for students requiring either Level I or Level II services. Level I services, means the provision of special education to children with disabilities for less than 50 percent of their instructional school day (excluding intermission for meals). Level II services, means the provision of special education and related services to children with disabilities for 50 percent or more of the instructional school day (excluding intermission for meals). The time that a child receives special education services is calculated on the basis of special education services described in the individualized education program, rather than the location of services.]***

Local school division caseload maximums as funded by the Virginia Appropriation Act

Disability Category	*Level II*		*Level I*
	With Paraprofessional 100% of the time	*Without Paraprofessional 100% of the Time*	
Autism	*8*	*6*	*24*
Deaf-blindness	*8*	*6*	
Developmental Delay: age 5-6	*10*	*8*	
Developmental Delay: age 2-5	*8 Center-based 10 Combined*	*12 Home-based and/or Itinerant*	
Emotional Disability	*10*	*8*	*24*
Hearing Impairment/Deaf	*10*	*8*	*24*
Learning Disability	*10*	*8*	*24*
Intellectual Disability	*10*	*8*	*24*
Multiple Disabilities	*8*	*6*	
Orthopedic Impairment	*10*	*8*	*24*
Other Health Impaired	*10*	*8*	*24*
Speech or Language Impairment	*NA*	*NA*	*68 (Itinerant)*
Traumatic Brain Injury	*May be placed in any program, according to the individualized education program.*		
Combined group of students needing Level I services with students needing Level II services	*20 Points (see values for students receiving Level I services when combined with students receiving Level II services)*		

Values for students receiving Level I services when combined with students receiving Level II services

Disability Category	*Level II Values*		*Level I*
	With Paraprofessional 100% of the time	*Without Paraprofessional 100% of the time*	*Values*
Autism	*2.5*	*3.3*	*1*
Deaf-blindness	*2.5*	*3.3*	*1*
Developmental Delay: age 5-6	*2.0*	*2.5*	*1*
Emotional Disability	*2.0*	*2.5*	*1*
Hearing Impairment/Deaf	*2.0*	*2.5*	*1*
Learning Disability	*2.0*	*2.5*	*1*
Intellectual Disability	*2.0*	*2.5*	*1*
Multiple Disabilities	*2.5*	*3.3*	*1*
Orthopedic Impairment	*2.0*	*2.5*	*1*
Other Health Impairment	*2.0*	*2.5*	*1*
Traumatic Brain Injury	*2.0*	*2.5*	*1*

3. Local school boards shall employ one licensed, full-time equivalent position per 1,000 students in grades kindergarten through 12 for gifted education services.

4. Each local school board shall employ licensed, full-time equivalent positions in career and technical education necessary to comply with the following requirements:

a. Career and technical education laboratory classes that use equipment that has been identified by the U.S. Department of Labor for hazardous occupations shall be limited to a maximum of 20 students per laboratory.

b. Career and technical education courses approved for students who are disadvantaged shall be limited to an average of 15 students per instructor per class period with no class being more than 18.

c. Career and technical education courses approved for students with disabilities shall be limited to an average of 10 students per instructor per class period with no class being more than 12 or up to an average of 12 students per class period with no class being more than 15 where an instructional aide is provided.

d. Enrollments in career and technical education courses shall not exceed the number of individual work stations.

e. Career and technical education programs using the cooperative education method of instruction shall be limited to an average of 20 students per instructor per class period with no class being more than 24 where the cooperative education method of instruction is required and have a class period assigned to the instructor for on-the-job coordination for each 20 students participating in on-the-job training.

E. In addition to the positions supported by basic aid and in support of regular school year programs of prevention, intervention, and remediation, state funding, pursuant to the appropriation act, shall be provided to fund certain full-time equivalent instructional positions for each 1,000 students in grades K through 12 who are identified as needing prevention, intervention, and remediation services. State funding for prevention, intervention, and remediation programs provided pursuant to this subsection and the appropriation act may be used to support programs for educationally at-risk students as identified by the local school boards.

To provide flexibility in the provision of mathematics intervention services, school divisions may use the state Standards of Learning Algebra Readiness initiative funding and the required local matching funds, pursuant to § 22.1-253.13, paragraph D, 12, to employ mathematics teacher specialists to provide the required mathematics intervention services. School divisions using the Standards of Learning Algebra Readiness initiative funding in this manner shall only employ instructional personnel licensed by the Board of Education.

F. In addition to the positions supported by basic aid and those in support of regular school year programs of prevention, intervention, and remediation, state funding, pursuant to the appropriation act, shall be provided to support 17 full-time equivalent instructional positions for each 1,000 students identified as having limited English proficiency.

To provide flexibility in the instruction of English Language Learners who have limited English proficiency and who are at risk of not meeting state accountability standards, school divisions may use state and local funds from the Standards of Quality Prevention, Intervention, and Remediation account to employ additional English Language Learner teachers to provide instruction to identified limited English proficiency students. Using these funds in this manner is intended to supplement the instructional services provided through the Standards of Quality staffing standard of 17 instructional positions per 1,000 limited English proficiency students. School divisions using the Standards of Quality Prevention, Intervention, and Remediation funds in this manner shall only employ instructional personnel licensed by the Board of Education.

G. In addition to the full-time equivalent positions required elsewhere in this section, each local school board shall employ the following reading specialists in elementary schools, one full-time in each elementary school at the discretion of the local school board.

To provide flexibility in the provision of reading intervention services, school divisions may use the state Early Reading Intervention initiative funding and the required local matching funds, pursuant to § 22.1-253.13, paragraph D, 12, to employ reading specialists to provide the required reading intervention services. School divisions using

the Early Reading Intervention Initiative funds in this manner shall only employ instructional personnel licensed by the Board of Education.

H. Each local school board shall employ, at a minimum, the following full-time equivalent positions for any school that reports fall membership, according to the type of school and student enrollment:

1. Principals in elementary schools, one half-time to 299 students, one full-time at 300 students; principals in middle schools, one full-time, to be employed on a 12-month basis; principals in high schools, one full-time, to be employed on a 12-month basis;

2. Assistant principals in elementary schools, one half-time at 600 students, one full-time at 900 students; assistant principals in middle schools, one full-time for each 600 students; assistant principals in high schools, one full-time for each 600 students.

School divisions that employ a sufficient number of assistant principals to meet these staffing requirements may assign assistant principals to schools within the division according to the area of greatest need, regardless of whether such schools are elementary, middle, or secondary.

3. Librarians in elementary schools, one part-time to 299 students, one full-time at 300 students; librarians in middle schools, one-half time to 299 students, one full-time at 300 students, two full-time at 1,000 students; librarians in high schools, one half-time to 299 students, one full-time at 300 students, two full-time at 1,000 students;

4. Guidance counselors in elementary schools, one hour per day per 100 students, one full-time at 500 students, one hour per day additional time per 100 students or major fraction thereof; guidance counselors in middle schools, one period per 80 students, one full-time at 400 students, one additional period per 80 students or major fraction thereof; guidance counselors in high schools, one period per 70 students, one full-time at 350 students, one additional period per 70 students or major fraction thereof; and

~~*5. Clerical personnel in elementary schools, part-time to 299 students, one full-time at 300 students; clerical personnel in middle schools, one full-time and one additional full-time for each 600 students beyond 200 students and one full-time for the library at 750 students; clerical personnel in high schools, one full-time and one additional full-time for each 600 students beyond 200 students and one full-time for the library at 750 students.*~~

I. Local school boards shall employ five full-time equivalent positions per 1,000 students in grades kindergarten through five to serve as elementary resource teachers in art, music, and physical education.

J. Local school boards shall employ two full-time equivalent positions per 1,000 students in grades kindergarten through 12, one to provide technology support and one to serve as an instructional technology resource teacher.

To provide flexibility, school divisions may use the state and local funds for instructional technology resource teachers to employ a data coordinator position, an instructional technology resource teacher position, or a data coordinator/instructional resource teacher blended position. The data coordinator position is intended to serve as a resource to principals and classroom teachers in the area of data analysis and interpretation for instructional and school improvement purposes, as well as for overall

data management and administration of state assessments. School divisions using these Standards of Quality funds in this manner shall only employ instructional personnel licensed by the Board of Education.

K. Local school boards may employ additional positions that exceed these minimal staffing requirements. These additional positions may include, but are not limited to, those funded through the state's incentive and categorical programs as set forth in the appropriation act.

L. A combined school, such as kindergarten through 12, shall meet at all grade levels the staffing requirements for the highest grade level in that school; this requirement shall apply to all staff, except for guidance counselors, and shall be based on the school's total enrollment; guidance counselor staff requirements shall, however, be based on the enrollment at the various school organization levels, i.e., elementary, middle, or high school. The Board of Education may grant waivers from these staffing levels upon request from local school boards seeking to implement experimental or innovative programs that are not consistent with these staffing levels.

M. School boards shall, however, annually, on or before January 1, report to the public the actual pupil/teacher ratios in elementary school classrooms by school for the current school year. Such actual ratios shall include only the teachers who teach the grade and class on a full-time basis and shall exclude resource personnel. School boards shall report pupil/teacher ratios that include resource teachers in the same annual report. Any classes funded through the voluntary kindergarten through third grade class size reduction program shall be identified as such classes. Any classes having waivers to exceed the requirements of this subsection shall also be identified. Schools shall be identified; however, the data shall be compiled in a manner to ensure the confidentiality of all teacher and pupil identities.

N. Students enrolled in a public school on a less than full-time basis shall be counted in ADM in the relevant school division. Students who are either (i) enrolled in a nonpublic school or (ii) receiving home instruction pursuant to § 22.1-254.1, and who are enrolled in public school on a less than full-time basis in any mathematics, science, English, history, social science, career and technical education, fine arts, foreign language, or health education or physical education course shall be counted in the ADM in the relevant school division on a pro rata basis as provided in the appropriation act. Each such course enrollment by such students shall be counted as 0.25 in the ADM; however, no such nonpublic or home school student shall be counted as more than one-half a student for purposes of such pro rata calculation. Such calculation shall not include enrollments of such students in any other public school courses.

O. Each local school board shall provide those support services that are necessary for the efficient and cost-effective operation and maintenance of its public schools.

For the purposes of this title, unless the context otherwise requires, "support services *positions*" shall include ~~*services provided by the school board members; the superintendent; assistant superintendents; student services (including guidance counselors, social workers, and homebound, improvement, principal's office, and library-media positions); attendance and health positions; administrative, technical, and clerical*~~

~~*positions; operation and maintenance positions; educational technology positions; school nurses; and pupil transportation positions.*~~ *the following:*

1. *Executive policy and leadership positions, including school board members, superintendent, and assistant superintendents;*
2. *Fiscal and human resource positions, including fiscal and audit operations, human resources, and procurement;*
3. *Student support positions, which include:*
    a. *Social workers and social work administrative positions;*
    b. *Guidance administrative positions not included in paragraph H.4, ,*
    c. *Homebound administrative positions supporting instruction;*
    d. *Attendance support positions related to truancy and drop-out prevention;*
    e. *Health and behavioral positions, including school nurses and school psychologists;*
4. *Instructional personnel support, including professional development positions and library and media positions not included in H.3;*
5. *Technology professional positions not included in paragraph J;*
6. *Operation and maintenance positions, including facilities; pupil transportation positions; operation, and maintenance professional and service positions; security services, trades, and laborer positions;*
7. *Technical and clerical positions, including fiscal and human resource technical/clerical, student support technical/clerical, instructional personnel support technical/clerical, operation and maintenance technical/clerical, administration technical/clerical, and technology technical/clerical positions;*
8. *School-based clerical personnel in elementary schools, part-time to 299 students, one full-time at 300 students; clerical personnel in middle schools, one full-time and one additional full-time for each 600 students beyond 200 students and one full-time for the library at 750 students; clerical personnel in high schools, one full-time and one additional full-time for each 600 students beyond 200 students and one full-time for the library at 750 students.*

Pursuant to the appropriation act, support services shall be funded from basic school aid on the basis of prevailing statewide costs *unless the Standards of Quality specify a staffing standard.*

School divisions may use the state and local funds for support services to provide additional instructional services.

Local school divisions shall report publicly the state and local amounts budgeted and expended for each category of support services listed above. Local school divisions shall also report publicly the amounts they received for support services that were used to provide additional instructional services.

§ 22.1-253.13:3. Standard 3. Accreditation, other standards and evaluation.

A. The Board of Education shall promulgate regulations establishing standards for accreditation pursuant to the Administrative Process Act (§ 2.2-4000 et seq.), which shall include, but not be limited to, student outcome measures, requirements and guidelines for

instructional programs and for the integration of educational technology into such instructional programs, administrative and instructional staffing levels and positions, including staff positions for supporting educational technology, student services, auxiliary education programs such as library and media services, course and credit requirements for graduation from high school, community relations, and the philosophy, goals, and objectives of public education in Virginia.

The Board shall review annually the accreditation status of all schools in the Commonwealth.

Each local school board shall maintain schools that are fully accredited pursuant to the standards for accreditation as prescribed by the Board of Education. Each local school board shall review the accreditation status of all schools in the local school division annually in public session. Within the time specified by the Board of Education, each school board shall submit corrective action plans for any schools within its school division that have been designated as not meeting the standards as approved by the Board.

When the Board of Education has obtained evidence through the school academic review process that the failure of schools within a division to achieve full accreditation status is related to division level failure to implement the Standards of Quality, the Board may require a division level academic review. After the conduct of such review and within the time specified by the Board of Education, each school board shall submit for approval by the Board a corrective action plan, consistent with criteria established by the Board and setting forth specific actions and a schedule designed to ensure that schools within its school division achieve full accreditation status. Such corrective action plans shall be part of the relevant school division's comprehensive plan pursuant to § 22.1-253.13:6.

With such funds as are appropriated or otherwise received for this purpose, the Board shall adopt and implement an academic review process, to be conducted by the Department of Education, to assist schools that are accredited with warning. The Department shall forward a report of each academic review to the relevant local school board, and such school board shall report the results of such academic review and the required annual progress reports in public session. The local school board shall implement any actions identified through the academic review and utilize them for improvement planning.

B. The Superintendent of Public Instruction shall develop and the Board of Education shall approve criteria for determining and recognizing educational performance in the Commonwealth's public school divisions and schools. Such criteria, when approved, shall become an integral part of the accreditation process and shall include student outcome measurements. The Superintendent of Public Instruction shall annually identify to the Board those school divisions and schools that exceed or do not meet the approved criteria. Such identification shall include an analysis of the strengths and weaknesses of public education programs in the various school divisions in Virginia and recommendations to the General Assembly for further enhancing student learning uniformly across the Commonwealth. In recognizing educational performance in the school divisions, the Board shall include consideration of special school division accomplishments, such as numbers of dual enrollments and students in Advanced

Placement and International Baccalaureate courses, and participation in academic year Governor's Schools.

The Superintendent of Public Instruction shall assist local school boards in the implementation of action plans for increasing educational performance in those school divisions and schools that are identified as not meeting the approved criteria. The Superintendent of Public Instruction shall monitor the implementation of and report to the Board of Education on the effectiveness of the corrective actions taken to improve the educational performance in such school divisions and schools.

C. With such funds as are available for this purpose, the Board of Education shall prescribe assessment methods to determine the level of achievement of the Standards of Learning objectives by all students. Such assessments shall evaluate knowledge, application of knowledge, critical thinking, and skills related to the Standards of Learning being assessed. The Board shall (i) in consultation with the chairpersons of the eight regional superintendents' study groups, establish a timetable for administering the Standards of Learning assessments to ensure genuine end-of-course and end-of-grade testing and (ii) with the assistance of independent testing experts, conduct a regular analysis and validation process for these assessments.

In prescribing such Standards of Learning assessments, the Board shall provide local school boards the option of administering tests for United States History to 1877, United States History: 1877 to the Present, and Civics and Economics. The last administration of the cumulative grade eight history test will be during the 2007-2008 academic school year. Beginning with the 2008-2009 academic year, all school divisions shall administer the United States History to 1877, United States History: 1877 to the Present, and Civics and Economics tests. The Board shall also provide the option of industry certification and state licensure examinations as a student-selected verified credit.

The Board of Education shall make publicly available such assessments in a timely manner and as soon as practicable following the administration of such tests, so long as the release of such assessments does not compromise test security or deplete the bank of assessment questions necessary to construct subsequent tests, or limit the ability to test students on demand and provide immediate results in the web-based assessment system.

The Board shall include in the student outcome measures that are required by the Standards for Accreditation end-of-course or end-of-grade tests for various grade levels and classes, as determined by the Board, in accordance with the Standards of Learning. These Standards of Learning assessments shall include, but need not be limited to, end-of-course or end-of-grade tests for English, mathematics, science, and history and social science.

In addition, to assess the educational progress of students, the Board of Education shall (i) develop appropriate assessments, which may include criterion-referenced tests and alternative assessment instruments that may be used by classroom teachers; (ii) select appropriate industry certification and state licensure examinations and (iii) prescribe and provide measures, which may include nationally normed tests to be used to identify students who score in the bottom quartile at selected grade levels.

The Standard of Learning requirements, including all related assessments, shall be waived for any student awarded a scholarship under the Brown v. Board of Education Scholarship Program, pursuant to § 30-231.2, who is enrolled in a preparation program for the General Education Development (GED) certificate or in an adult basic education program to obtain the high school diploma.

The Board of Education may adopt special provisions related to the administration and use of any SOL test or tests in a content area as applied to accreditation ratings for any period during which the SOL content or assessments in that area are being revised and phased in. Prior to statewide administration of such tests, the Board of Education shall provide notice to local school boards regarding such special provisions.

D. The Board of Education may pursue all available civil remedies pursuant to § 22.1-19.1 or administrative action pursuant to § 22.1-292.1 for breaches in test security and unauthorized alteration of test materials or test results.

The Board may initiate or cause to be initiated a review or investigation of any alleged breach in security, unauthorized alteration, or improper administration of tests by local school board employees responsible for the distribution or administration of the tests.

Records and other information furnished to or prepared by the Board during the conduct of a review or investigation may be withheld pursuant to subdivision 12 of § 2.2-3705.3. However, this section shall not prohibit the disclosure of records to (i) a local school board or division superintendent for the purpose of permitting such board or superintendent to consider or to take personnel action with regard to an employee or (ii) any requester, after the conclusion of a review or investigation, in a form that (a) does not reveal the identity of any person making a complaint or supplying information to the Board on a confidential basis and (b) does not compromise the security of any test mandated by the Board. Any local school board or division superintendent receiving such records or other information shall, upon taking personnel action against a relevant employee, place copies of such records or information relating to the specific employee in such person's personnel file.

Notwithstanding any other provision of state law, no test or examination authorized by this section, including the Standards of Learning assessments, shall be released or required to be released as minimum competency tests, if, in the judgment of the Board, such release would breach the security of such test or examination or deplete the bank of questions necessary to construct future secure tests.

E. With such funds as may be appropriated, the Board of Education may provide, through an agreement with vendors having the technical capacity and expertise to provide computerized tests and assessments, and test construction, analysis, and security, for (i) web-based computerized tests and assessments for the evaluation of student progress during and after remediation and (ii) the development of a remediation item bank directly related to the Standards of Learning.

F. To assess the educational progress of students as individuals and as groups, each local school board shall require the use of Standards of Learning assessments and other relevant data, such as industry certification and state licensure examinations, to evaluate student progress and to determine educational performance. Each local school shall

require the administration of appropriate assessments to all students for grade levels and courses identified by the Board of Education, which may include criterion-referenced tests, teacher-made tests and alternative assessment instruments and shall include the Standards of Learning Assessments and the National Assessment of Educational Progress state-by-state assessment. Each school board shall analyze and report annually, in compliance with any criteria that may be established by the Board of Education, the results from the Stanford Achievement Test Series, Ninth Edition (Stanford Nine) assessment, if administered, industry certification examinations, and the Standards of Learning Assessments to the public.

The Board of Education shall not require administration of the Stanford Achievement Test Series, Ninth Edition (Stanford Nine) assessment, except as may be selected to facilitate compliance with the requirements for home instruction pursuant to § 22.1-254.1.

The Board shall include requirements for the reporting of the Standards of Learning assessment scores and averages for each year as part of the Board's requirements relating to the School Performance Report Card. Such scores shall be disaggregated for each school by student subgroups on the Virginia assessment program as appropriate and shall be reported to the public within three months of their receipt. These reports (i) shall be posted on the portion of the Department of Education's website relating to the School Performance Report Card, in a format and in a manner that allows year-to-year comparisons, and (ii) may include the National Assessment of Educational Progress state-by-state assessment.

G. Each local school division superintendent shall regularly review the division's submission of data and reports required by state and federal law and regulations to ensure that all information is accurate and submitted in a timely fashion. The Superintendent of Public Instruction shall provide a list of the required reports and data to division superintendents annually. The status of compliance with this requirement shall be included in the Board of Education's annual report to the Governor and the General Assembly as required by § 22.1-18.

§ 22.1-253.13:4. Standard 4. Student achievement and graduation requirements.

A. Each local school board shall award diplomas to all secondary school students, including students who transfer from nonpublic schools or from home instruction, who earn the units of credit prescribed by the Board of Education, pass the prescribed tests, and meet such other requirements as may be prescribed by the local school board and approved by the Board of Education. Provisions shall be made to facilitate the transfer and appropriate grade placement of students from other public secondary schools, from nonpublic schools, or from home instruction as outlined in the standards for accreditation. Course credits earned for online courses taken in the Department of Education's Virtual Virginia program shall transfer to Virginia public schools in accordance with provisions of the standards for accreditation. Further, reasonable accommodation to meet the requirements for diplomas shall be provided for otherwise qualified students with disabilities as needed.

In addition, each local school board may devise, vis-a-vis the award of diplomas to secondary school students, a mechanism for calculating class rankings that takes into

consideration whether the student has taken a required class more than one time and has had any prior earned grade for such required class expunged.

Each local school board shall notify the parents of rising eleventh and twelfth grade students of (i) the number and subject area requirements of standard and verified units of credit required for graduation pursuant to the standards for accreditation and (ii) the remaining number and subject area requirements of such units of credit the individual student requires for graduation.

B. Students identified as disabled who complete the requirements of their individualized education programs shall be awarded special diplomas by local school boards.

Each local school board shall notify the parent of such students with disabilities who have an individualized education program and who fail to meet the requirements for a standard or advanced studies diploma of the student's right to a free and appropriate education to age 21, inclusive, pursuant to Article 2 (§ 22.1-213 et seq.) of Chapter 13 of this title.

C. Students who have completed a prescribed course of study as defined by the local school board shall be awarded certificates of program completion by local school boards if they are not eligible to receive a standard, advanced studies, modified standard, special, or general achievement diploma.

Each local school board shall provide notification of the right to a free public education for students who have not reached 20 years of age on or before August 1 of the school year, pursuant to Chapter 1 (§ 22.1-1 et seq.) of this title, to the parent of students who fail to graduate or who have failed to achieve the number of verified units of credit required for graduation as provided in the standards for accreditation. If such student who does not graduate or achieve such verified units of credit is a student for whom English is a second language, the local school board shall notify the parent of the student's opportunity for a free public education in accordance with § 22.1-5.

D. In establishing course and credit requirements for a high school diploma, the Board shall:

1. Provide for the selection of integrated learning courses meeting the Standards of Learning and approved by the Board to satisfy graduation credit requirements, which shall include Standards of Learning testing, as necessary;

2. Establish the requirements for a standard, modified standard, or advanced studies high school diploma, which shall include one credit in fine or performing arts or career and technical education and one credit in United States and Virginia history. The requirements for a standard high school diploma shall, however, include at least two sequential electives chosen from a concentration of courses selected from a variety of options that may be planned to ensure the completion of a focused sequence of elective courses. Students may take such focused sequence of elective courses in consecutive years or any two years of high school. Such focused sequence of elective courses shall provide a foundation for further education or training or preparation for employment and shall be developed by the school division, consistent with Board of Education guidelines and as approved by the local school board;

3. Establish the requirements for a technical diploma. This diploma shall meet or exceed the requirements of a standard diploma and will include a concentration in career and technical education, as established in Board regulations. A student who meets the requirement for the advanced studies diploma who also fulfills a concentration in career and technical education shall receive an advanced technical diploma, or if he chooses, he shall receive an advanced studies diploma. The Board may develop or designate assessments in career and technical education for the purposes of awarding verified credit pursuant to subdivision 6;

4. Provide, in the requirements for the verified units of credit stipulated for obtaining the standard or advanced studies diploma, that students completing elective classes into which the Standards of Learning for any required course have been integrated may take the relevant Standards of Learning test for the relevant required course and receive, upon achieving a satisfactory score on the specific Standards of Learning assessment, a verified unit of credit for such elective class that shall be deemed to satisfy the Board's requirement for verified credit for the required course;

5. Establish a procedure to facilitate the acceleration of students that allows qualified students, with the recommendation of the division superintendent, without completing the 140-hour class, to obtain credit for such class upon demonstration of mastery of the course content and objectives. Having received credit for the course, the student shall be permitted to sit for the relevant Standards of Learning assessment and, upon receiving a passing score, shall earn a verified credit.

6. Provide for the award of verified units of credit for passing scores on industry certifications, state licensure examinations, and national occupational competency assessments approved by the Board of Education.

School boards shall report annually to the Board of Education the number of industry certifications obtained, state licensure examinations passed, and the number of career and technical education completers that graduated. These numbers shall be reported as categories on the School Performance Report Card.

For the purposes of this subdivision, a "career and technical education completer" is a student who has met the requirements for a career and technical concentration or specialization and all requirements for high school graduation or an approved alternative education program.

In addition, the Board may:

a. For the purpose of awarding verified units of credit, approve the use of additional or substitute tests for the correlated Standards of Learning assessment, such as academic achievement tests, industry certifications or state licensure examinations; and

b. Permit students completing career and technical education programs designed to enable such students to pass such industry certification examinations or state licensure examinations to be awarded, upon obtaining satisfactory scores on such industry certification or licensure examinations, the appropriate verified units of credit for one or more career and technical education classes into which relevant Standards of Learning for various classes taught at the same level have been integrated. Such industry certification and state licensure examinations may cover relevant Standards of Learning for various

required classes and may, at the discretion of the Board, address some Standards of Learning for several required classes.

E. In the exercise of its authority to recognize exemplary academic performance by providing for diploma seals, the Board of Education shall develop criteria for recognizing exemplary performance in career and technical education programs by students who have completed the requirements for a standard or advanced studies diploma and shall award seals on the diplomas of students meeting such criteria.

In addition, the Board shall establish criteria for awarding a diploma seal for advanced mathematics and technology for the standard and advanced studies diplomas. The Board shall consider including criteria for (i) technology courses; (ii) technical writing, reading, and oral communication skills; (iii) technology-related training; and (iv) industry, professional, and trade association national certifications.

The Board shall also establish criteria for awarding a diploma seal for excellence in civics education and understanding of our state and federal constitutions and the democratic model of government for the standard and advanced studies diplomas. The Board shall consider including criteria for (i) successful completion of history, government, and civics courses, including courses that incorporate character education; (ii) voluntary participation in community service or extracurricular activities that includes the types of activities that shall qualify as community service and the number of hours required; and (iii) related requirements as it deems appropriate.

F. The Board shall establish, by regulation, requirements for the award of a general achievement diploma for those persons who have (i) achieved a passing score on the GED examination; (ii) successfully completed an education and training program designated by the Board of Education; and (iii) satisfied other requirements as may be established by the Board for the award of such diploma.

G. To ensure the uniform assessment of high school graduation rates, the Board shall collect, analyze, and report high school graduation and dropout data using a formula prescribed by the Board.

The Board may promulgate such regulations as may be necessary and appropriate for the collection, analysis, and reporting of such data.

§ 22.1-253.13:5. Standard 5. Quality of classroom instruction and educational leadership.

A. Each member of the Board of Education shall participate in high-quality professional development programs on personnel, curriculum and current issues in education as part of his service on the Board.

B. Consistent with the finding that leadership is essential for the advancement of public education in the Commonwealth, teacher, administrator, and superintendent evaluations shall be consistent with the performance objectives included in the Guidelines for Uniform Performance Standards and Evaluation Criteria for Teachers, Administrators, and Superintendents. Teacher evaluations shall include regular observation and evidence that instruction is aligned with the school's curriculum. Evaluations shall include

identification of areas of individual strengths and weaknesses and recommendations for appropriate professional activities.

C. The Board of Education shall provide guidance on high-quality professional development for (i) teachers, principals, supervisors, division superintendents and other school staff; (ii) administrative and supervisory personnel in the evaluation and documentation of teacher and administrator performance based on student academic progress and the skills and knowledge of such instructional or administrative personnel; (iii) school board members on personnel, curriculum and current issues in education; and (iv) programs in Braille for teachers of the blind and visually impaired, in cooperation with the Virginia Department for the Blind and Vision Impaired.

The Board shall also provide technical assistance on high-quality professional development to local school boards designed to ensure that all instructional personnel are proficient in the use of educational technology consistent with its comprehensive plan for educational technology.

D. Each local school board shall require (i) its members to participate annually in high-quality professional development activities at the state, local, or national levels on governance, including, but not limited to, personnel policies and practices; curriculum and instruction; use of data in planning and decision making; and current issues in education as part of their service on the local board and (ii) the division superintendent to participate annually in high-quality professional development activities at the local, state or national levels

E. Each local school board shall provide a program of high-quality professional development (i) in the use and documentation of performance standards and evaluation criteria based on student academic progress and skills for teachers and administrators to clarify roles and performance expectations and to facilitate the successful implementation of instructional programs that promote student achievement at the school and classroom levels; (ii) as part of the license renewal process, to assist teachers and principals in acquiring the skills needed to work with gifted students, students with disabilities, and students who have been identified as having limited English proficiency and to increase student achievement and expand the knowledge and skills students require to meet the standards for academic performance set by the Board of Education; (iii) in educational technology for all instructional personnel which is designed to facilitate integration of computer skills and related technology into the curricula, and (iv) for administrative personnel designed to increase proficiency in instructional leadership and management, including training in the evaluation and documentation of teacher and administrator performance based on student academic progress and the skills and knowledge of such instructional or administrative personnel.

In addition, each local school board shall also provide teachers and principals with high-quality professional development programs each year in (i) instructional content; (ii) the preparation of tests and other assessment measures; (iii) methods for assessing the progress of individual students, including Standards of Learning assessment materials or other criterion-referenced tests that match locally developed objectives; (iv) instruction and remediation techniques in English, mathematics, science, and history and social

science; (v) interpreting test data for instructional purposes; (vi) technology applications to implement the Standards of Learning; and (vii) effective classroom management.

F. Schools and school divisions shall include as an integral component of their comprehensive plans required by § 22.1-253.13:6, high-quality professional development programs that support the recruitment, employment, and retention of qualified teachers and principals. Each school board shall require all instructional personnel to participate each year in these professional development programs.

G. Each local school board shall annually review its professional development program for quality, effectiveness, participation by instructional personnel, and relevancy to the instructional needs of teachers and the academic achievement needs of the students in the school division.

§ 22.1-253.13:6. Standard 6. Planning and public involvement.

A. The Board of Education shall adopt a statewide comprehensive, unified, long-range plan based on data collection, analysis, and evaluation. Such plan shall be developed with statewide participation. The Board shall review the plan biennially and adopt any necessary revisions. The Board shall post the plan on the Department of Education's website if practicable, and, in any case, shall make a hard copy of such plan available for public inspection and copying.

This plan shall include the objectives of public education in Virginia, including strategies for first improving student achievement, particularly the achievement of educationally at-risk students, then maintaining high levels of student achievement; an assessment of the extent to which these objectives are being achieved; a forecast of enrollment changes; and an assessment of the needs of public education in the Commonwealth. In the annual report required by § 22.1-18, the Board shall include an analysis of the extent to which these Standards of Quality have been achieved and the objectives of the statewide comprehensive plan have been met. The Board shall also develop, consistent with, or as a part of, its comprehensive plan, a detailed comprehensive, long-range plan to integrate educational technology into the Standards of Learning and the curricula of the public schools in Virginia, including career and technical education programs. The Board shall review and approve the comprehensive plan for educational technology and may require the revision of such plan as it deems necessary.

B. Each local school board shall adopt a divisionwide comprehensive, unified, long-range plan based on data collection, an analysis of the data, and how the data will be utilized to improve classroom instruction and student achievement. The plan shall be developed with staff and community involvement and shall include, or be consistent with, all other divisionwide plans required by state and federal laws and regulations. Each local school board shall review the plan biennially and adopt any necessary revisions. Prior to the adoption of any divisionwide comprehensive plan or revisions thereto, each local school board shall post such plan or revisions on the division's Internet website if practicable, and, in any case, shall make a hard copy of the plan or revisions available for public inspection and copying and shall conduct at least one public hearing to solicit public comment on the divisionwide plan or revisions.

The divisionwide comprehensive plan shall include, but shall not be limited to, (i) the objectives of the school division, including strategies for first improving student achievement, particularly the achievement of educationally at-risk students, then maintaining high levels of student achievement; (ii) an assessment of the extent to which these objectives are being achieved; (iii) a forecast of enrollment changes; (iv) a plan for projecting and managing enrollment changes including consideration of the consolidation of schools to provide for a more comprehensive and effective delivery of instructional services to students and economies in school operations; (v) an evaluation of the appropriateness of establishing regional programs and services in cooperation with neighboring school divisions; (vi) a plan for implementing such regional programs and services when appropriate; (vii) a technology plan designed to integrate educational technology into the instructional programs of the school division, including the school division's career and technical education programs, consistent with, or as a part of, the comprehensive technology plan for Virginia adopted by the Board of Education; (viii) an assessment of the needs of the school division and evidence of community participation, including parental participation, in the development of the plan; (ix) any corrective action plan required pursuant to § 22.1-253.13:3; and (x) a plan for parent and family involvement to include building successful school and parent partnerships that shall be developed with staff and community involvement, including participation by parents.

A report shall be presented by each school board to the public by November 1 of each odd-numbered year on the extent to which the objectives of the divisionwide comprehensive plan have been met during the previous two school years.

C. Each public school shall also prepare a comprehensive, unified, long-range plan, which the relevant school board shall consider in the development of its divisionwide comprehensive plan.

D. The Board of Education shall, in a timely manner, make available to local school boards information about where current Virginia school laws, Board regulations and revisions, and copies of relevant Opinions of the Attorney General of Virginia may be located online.

§ 22.1-253.13:7. Standard 7. School board policies.

A. Each local school board shall develop policies and procedures to address complaints of sexual abuse of a student by a teacher or other school board employee.

B. Each local school board shall maintain and follow up-to-date policies. All school board policies shall be reviewed at least every five years and revised as needed.

C. Each local school board shall ensure that policies are developed giving consideration to the views of teachers, parents, and other concerned citizens and addressing the following:

1. A system of two-way communication between employees and the local school board and its administrative staff whereby matters of concern can be discussed in an orderly and constructive manner;

2. The selection and evaluation of all instructional materials purchased by the school division, with clear procedures for handling challenged controversial materials;

3. The standards of student conduct and attendance and enforcement procedures designed to provide that public education be conducted in an atmosphere free of disruption and threat to persons or property and supportive of individual rights;

4. School-community communications and community involvement;

5. Guidelines to encourage parents to provide instructional assistance to their children in the home, which may include voluntary training for the parents of children in grades K through three;

6. Information about procedures for addressing concerns with the school division and recourse available to parents pursuant to § 22.1-87;

7. A cooperatively developed procedure for personnel evaluation appropriate to tasks performed by those being evaluated; and

8. Grievances, dismissals, etc., of teachers, and the implementation procedure prescribed by the General Assembly and the Board of Education, as provided in Article 3 (§ 22.1-306 et seq.) of Chapter 15 of this title, and the maintenance of copies of such procedures.

D. A current copy of the school division policies, required by this section, including the Student Conduct Policy, shall be posted on the division's website and shall be available to employees and to the public. School boards shall ensure that printed copies of such policies are available as needed to citizens who do not have online access.

E. An annual announcement shall be made in each division at the beginning of the school year and, for parents of students enrolling later in the academic year, at the time of enrollment, advising the public that the policies are available in such places.

§ 22.1-253.13:8. Compliance.

The Standards of Quality prescribed in this chapter shall be the only standards of quality required by Article VIII, Section 2 of the Constitution of Virginia.

Each local school board shall provide, as a minimum, the programs and services, as provided in the Standards of Quality prescribed above, with state and local funds as apportioned by the General Assembly in the appropriation act and to the extent funding is provided by the General Assembly.

Each local school board shall report its compliance with the Standards of Quality to the Board of Education annually. The report of compliance shall be submitted to the Board of Education by the chairman of the local school board and the division superintendent.

Noncompliance with the Standards of Quality shall be included in the Board of Education's annual report to the Governor and the General Assembly as required by § 22.1-18.

As required by § 22.1-18, the Board of Education shall submit to the Governor and the General Assembly a report on the condition and needs of public education in the Commonwealth and shall identify any school divisions and the specific schools therein that have failed to establish and maintain schools meeting the existing prescribed Standards of Quality.

The Board of Education shall have authority to seek school division compliance with the foregoing Standards of Quality. When the Board of Education determines that a school division has failed or refused, and continues to fail or refuse, to comply with any such Standard, the Board may petition the circuit court having jurisdiction in the school division to mandate or otherwise enforce compliance with such standard, including the development or implementation of any required corrective action plan that a local school board has failed or refused to develop or implement in a timely manner.

Appendix E: Summary of Comments

Summary of Comments from First Public Comment Period

May 1, 2009 through July 31, 2009

General

- Continue to recommend the staffing standards that have been proposed by the Board, but have not been funded by the General Assembly.
- Seek full funding of the Standards of Quality (SOQ). Reject any attempts to cut state funding.
- Oppose the proposal to adopt a cap on the number of support positions.
- Resist efforts to enforce personnel support ratios that are based solely no cost-savings and not on evidence of their utility and contribution to the educational enterprise.
- Establish an instructional staffing baseline reflective of prevailing practices.
- Oppose lowering the Standards of Quality in any way.
- Prioritize mandates placed on local school divisions based what is truly core to a school division's mission.
- Consider taking flexibility concept further by asking how specific some of the standards need to be.
- Consider the Fairfax County School Board's advocacy positions on the SOQ that were in its 2009 Legislative Program.
- Take time to gather information documenting current needs and practices so that the SOQ will recognize the need for more SOQ-funded instructional positions.
- Do an in depth analysis of the data to determine if different ratios are necessary for differing school circumstances or different sized school systems.
- Conduct a complete and comprehensive review of the SOQ in conjunction with the Joint Legislative Audit and Review Commission (JLARC) of support staff positions with the objective of maximizing educational opportunities for Virginia's students.

Principals/Assistant Principals

- Require a full-time principal for every school.
- Require principals to be employed on a 12 month basis.
- Make the minimum number of students required for a principal or assistant principal at an elementary school the same as for the middle and the high school.
- Increase the elementary school assistant principal staffing ratio from 900 students to 1 assistant principal to 400 students to 1 principal.
- Do not supplant an assistant principal position by specifying that one assistant principal in each school function as a data coordinator.

Nurses

- Increase the standard for nurses.
- Require one Registered Nurse (RN) or Licensed Practical Nurse (LPN) in each school.
- Set the following staffing ratios for nurses in all schools: at least one half-time registered nurse to 299 students; at least one full-time registered nurse at 300 students; at least one half-time registered nurse for each additional 500 students over 1,000.

Reading Specialists

- Require a full time reading specialist in each school.
- Require additional reading services in certain schools based on a weighted formula.

Special Education

- Review the SOQ and funding mechanism for special education to ensure staffing patterns fit what is needed to implement current practices.
- Review the SOQ and funding mechanism to ensure that school division efforts to provide students with disabilities access to the general education curriculum are not hindered by funding incentives based on placement.
- Include caseload size for teachers of the vision impaired.

School Counselors

- Resist any effort to decrease funding of support personnel and no allow such things as testing and other duties to be given to the counselor which would further inhibit services to students.
- Continue to maintain a required school counselor/student ratio in the SOQ.
- Current ratio for school counselors is too high. Maintain a counselor/student ratio that is reasonable.
- Include qualified guidance personnel.

Gifted Education

- Require local school boards to employ one full-time equivalent position to plan, implement and evaluate gifted education services to ensure compliance with the Board's gifted education regulations. This instructional supervisor must be highly trained in gifted education as required by the licensure requirements for gifted education.
- Require local school boards to employ one full-time equivalent resource teacher position per 1,000 students in grades K-12. This resource teacher will be highly trained in gifted education as required by licensure regulations and their duties will be defined by each school division's comprehensive local plan.

English as a Second Language (ESL) Teachers

- Increase state funding for ESL teachers from 17 teachers per 1,000 students to 30 teachers per 1,000 students.

Data Coordinators

- Include one data coordinator for each school within the school divisions.
- Include data coordinators and/or testing coordinators.

School Psychologists

- School psychologists should be included in the SOQ.
- Include at least one psychologist for up to 2,000 students.
- Require school divisions to employ trained psychologists who are licensed by the Board of Education.

Summary of Comments from Second Public Comment Period

September 15 through October 2, 2009

General Funding and Support Staff

- Oppose permanent cuts to state funding for education.
- Revise the SOQ to require schools to provide for a minimum of one hour of planning time each day for all primary and elementary classroom teachers.
- Restore full funding and increase support for K-12 public education in Virginia.
- Support the educational policy issued September 17 to keep education strong for our students.
- Oppose capping the number of school support positions.
- Encourage increasing limited funds to those areas directly supporting instruction.
- An honest rebenchmarking figure with no support cap should be conveyed to the Governor and to the General Assembly.
- Support appropriateness of establishing ratio standards for individual categories of support personnel.
- Services such as counseling, attendance, nursing, custodians, school social workers, psychologists, and technology staff are essential to student education and welfare.
- Support the Board priority for the unfunded SOQ recommendations.
- Support codifying some of the staffing ratios that are funded in the Appropriation Act.
- Support greater partnerships with schools, parents, and community.
- Programs should be examined for efficiency and effectiveness.
- Request a separation in the term "support services" of those who provide direct services to students and those who provide an indirect service, i.e. school nurses, school social workers, school psychologists versus guidance administrative positions, homebound administrative, and other support positions, i.e. operation and maintenance.
- The proposed reduction in state funding for support staff would be a permanent change in how the state funds education, reducing the state's investment in students by $893 million on 2010-12.
- Reducing the support staff will have a tremendous impact on the 84,345 Limited English Proficient (LEP) students currently enrolled in Virginia's public schools.
- Adequate funding allocated to high quality teachers working with support staff will serve as a strong foundation to prepare students for success.
- Prescribe standards that maintain the high quality of education we have in Virginia.
- Permanent changes to staffing ratios will negatively impact K-12 programs for many years.
- If the state wants to develop staffing standards for support positions, then a proper study and analysis is recommended.
- The Board should enhance the standards to reflect the actual educational practice that has brought about the improvements and is supported by research, rather than reducing funding.

Nurses

- Examine the category for school nurses; school nursing is an area of increased need.
- Include a ratio for school nurses of one nurse for every 750 students in the SOQ.

Reading Specialists

- The goal continues to be the inclusion of reading specialists in the SOQ at a ratio of one to 1,000 students.
- Reading specialists are just as necessary as other support personnel.
- Flexibility in the employment of reading specialists with funds outside of the SOQ is appreciated, but additional funding is optimal.
- Continue to request the inclusion of reading specialists in the SOQ and funding at a ratio of one reading specialist per 1,000 students.

Special Education

- Support current funding practice for special education students.

School Counseling Programs

- Do not eliminate or reduce school counselor positions.
- Concerns are voiced that there is the possibility of counselor positions being eliminated.
- Without the guidance and counseling support personnel, the ability of professional school counselors to ensure the academic success of all students will be severely hampered.

Gifted Education

- Support the proposed staffing ratio for gifted resource teachers.
- The Board should maintain a high commitment to students in the gifted and talented population.
- Support staffing for gifted education in addition to and not in lieu of the current language of the Standards of Quality in Standard 2, Section D.
- Require local school boards to employ a minimum of one full-time equivalent position to plan, implement and evaluate gifted education services. This instructional supervisor must be highly trained in gifted education as required by the licensure requirements for gifted education.
- Require local school boards to employ one full-time equivalent resource teacher per 1,000 students in grades K-12. This resource teacher must be highly trained in gifted education as specified in the licensure requirements for the gifted education add-on endorsement and their duties must be defined by each school division's comprehensive local plan.

English as a Second Language (ESL)

- Consideration needs to be given to adding language to support an increase in funding of ESL teachers.
- Requests an increase in the staffing ratio to 30 teachers for every 1,000 students and two pupil personnel positions for every 1,000 students.
- Appreciates the recommended changes to allow flexibility in supplementing the funding proposed to support a ratio of 17 teachers to 1,000 people. However, the Virginia ESL Supervisors' Association (VESA) recommends an increase in funding to provide more support for English language learners.
- Consideration needs to be given to funding the required annual assessment of English language proficiency.

School Psychologists

- Include a ratio of at least one psychologist for every 2,000 students in the SOQ.
- Require school divisions to employ school counselors who are licensed by the Board of Education and who are trained in observing students in their environment, consulting with teachers, developing recommendations and implementing follow-up.

School Libraries

- Do not cut positions in school libraries, including clerical personnel.
- A full-time library aide is needed in every school.
- There is concern about the removal of the requirement for clerical staff in a high school library of 750 students.
- The staffing ratios for library media specialists and technology support personnel should be updated and increased to reflect the greater demand of implementing initiatives such as electronic textbooks and digital instructional materials as well as providing professional development support to Virginia's teachers.

Technology

- Keep the current state formula and funding for technology support and technology resource teacher positions.
- Do not eliminate the technology specialist position.
- Oppose any reduction in staffing ratios for technology/media support personnel.
- Oppose the proposal that would permit school divisions to use state and local funds for instructional technology resource teachers to employ a data coordinator position, an instructional technology resource teacher, or a data coordinator/instructional technology resource teacher blended position.
- Staffing ratios for library media specialists and technology support personnel should be updated and increased to reflect the greater demand of implementing initiatives such as electronic textbooks and digital instructional materials as well as providing professional development and support to Virginia's teachers.

- Virginia Society for Technology in Virginia (VSTE), a 5,500 member organization, supports the updating of technology staffing ratios to reflect the increased role of technology in instruction and assessment.

Career and Technical Education

- Any changes to staff ratios in career and technical education should not only reflect the needs of the schools, but also the needs of industry.

Speech Language Pathology Services

- Lower the caseload for speech language pathologists from 68 to 60.

Music, Art and Physical Education

- Require at a minimum that all elementary schools are staffed with one full-time licensed art teacher, one full-time licensed music teacher, and one full-time licensed physical education teacher.

Draft Policy Directives Adopted by the Board of Education on September 17, 2009

- Request that the Board advocate against any structural changes to the SOQ that result in decreased state funding for K-12 public education.
- Support the draft policy directive that would enhance the SOQ so that the basic foundation program for K-12 public education reflects a comprehensive educational program of the highest quality.
- Support the draft policy directive to advocate against permanent structural changes to the SOQ that results in decreased funding for K-12 public education.
- Support the draft policy directive regarding a principal in every school and increasing the number of assistant principals in schools with the greatest need.
- Support the draft policy directive to include gifted, special education, and career and technical education staffing ratios and certain incentive programs in the SOQ.
- Support the draft policy directive to set guidelines for alternative education.
- Oppose the draft policy directive to prioritize outstanding SOQ recommendations.
- Do not support the proposed changes to provide flexibility that would permit local school divisions to use the state and local funds for instructional technology resource teachers to employ a data coordinator position, an instructional technology resource teacher position, or a data coordinator/instructional resource teacher blended position.
- Support allowing school divisions flexibility in hiring specialists in reading, mathematics, and ESL, in deploying assistant principals to schools with the greatest need, and in using funds for support services to provide additional instructional services.
- Appreciates the recommended changes to allow flexibility in supplementing the funding proposed to support a ratio of 17 teachers to 1,000 people. However, the Virginia ESL Supervisors' Association (VESA) recommends an increase in funding to provide more support for English language learners.

- Supports the recommendation in the consultant report, dated September 2009, to eliminate the "cliffs" for instructional support positions.

Draft Changes to the SOQ

- Do not support the proposed language change to Standard 1 regarding early reading intervention services because it will result in increased testing, increased reporting requirements, does not recognize other local assessment options that may be proven effective, and will result in redirecting staff to non-instructional purposes.
- Does not support the proposed language change to Standard 1 regarding early mathematics intervention services because it is inappropriate for grades 6 and 7 and will result in increased testing, increased reporting requirements, and directing staff to non-instructional purposes. In addition, it is unfunded.
- Support the language changes to Standard 2.D.1. (page 7 of the proposed draft) – the inclusion of the 58 teachers per 1,000 student ratio.
- Support the language changes to Standard 2.D.1. (pages 7 and 8 of the proposed draft) that add special education positions and gifted education positions to the SOQ.
- Endorse the two recommendations of the Virginia Association for the Gifted for a minimum of one full-time equivalent position for planning, implementing and evaluating gifted education services and one full-time equivalent resource teacher per 1,000 students in grades K-12 in addition to and not in lieu of the current language in the SOQ.
- Do not support any of the changes to Standard 2.D.4., page 9 of the proposed draft, (the inclusion of the staffing standards for Career and Technical Education), unless the school division maintains the flexibility currently provided.
- Support changing the ESL ratio from 17 teachers for 1,000 students to 30 teachers per 1,000 students.
- Support the proposed changes to Standard 2.G. on page 10 of the draft (flexibility for reading specialists and the Early Intervention Reading Initiative), Standard 2.H.2. on page 10 (flexibility for assistant principals), Standard 2.J. on page 11 (flexibility language for instructional technology resource teachers and/or data coordinators) and Standard 2.O. on pages 12 and 13 (support position language).
- Supports the provision of early intervention reading and mathematics for students in grades K-3 and supports providing the results of diagnostic testing annually to the Superintendent of Public Instruction.
- Supports the establishment of a minimum number of instructional positions to be funded through the Appropriation Act.
- The SOQ are unclear as to the definition of Level I and Level II services.
- Do not support the requirement for increased staffing for gifted education.
- Clarification is needed regarding the limitation of CTE students to 15 per class with a cap of 18 students for students who are disadvantaged.
- Clarification is needed regarding the limitation on the number of CTE students with disabilities.
- Do not support a requirement to employ only licensed personnel using Algebra Readiness funds.

Appendix F: Rebenchmarking Presentation to the Virginia Board of Education – July 22, 2009

Rebenchmarking of the Direct Aid to Public Education Budget for the 2010-2012 Biennium

Presented to the Board of Education SOQ Committee

July 22, 2009

Kent C. Dickey
Assistant Superintendent for Finance

VIRGINIA DEPARTMENT OF EDUCATION

Briefing Outline

- Overview of Rebenchmarking Process
- Summary of Rebenchmarking Costs
- Analysis of Key Data Inputs Impacting 2010-2012 Rebenchmarked Cost
- Rebenchmarking Summary
- Appendices

Rebenchmarking Process

- The Virginia Constitution requires the Board of Education to formulate Standards of Quality (SOQ) for public schools.
- The General Assembly is charged with revising the SOQ, determining SOQ costs, and apportioning the cost between the state and localities.
- The decision about how much to appropriate for public schools is left to the General Assembly.
- Cost rebenchmarking process for public education funding occurs each odd-numbered year in parallel with the Commonwealth's biennial budget cycle.
- FY10 from the Chapter 781 budget serves as the base year funding against which the 2010-2012 rebenchmarking cost is determined.

Rebenchmarking Process

- **Rebenchmarking updates are technical in nature and do not involve changes in policy or funding methodology, other than those already approved and directed by the General Assembly.**

- **This includes showing the cost of rebenchmarking for the 2010-2012 biennium both with and without the support position funding cap, as required by Item 140, paragraph C.5.k.2), Chapter 781, 2009 Acts of Assembly, which states that the Department of Education:**

  "shall make its calculation for the total cost of rebenchmarking for the fiscal year 2010-2012 biennium to be consistent with the following methodologies: (i) using the 'support position funding cap' methodology change contained in House Bill 1600/Senate Bill 850, as introduced in the 2009 Session; and (ii) using the rebenchmarking methodology which was contained within Chapter 879, from the 2008 Session. The Department of Education shall report the final calculations and related costs derived from each of these methodologies to the Governor, the Chairmen of House Appropriations and Senate Finance Committees, and the Board of Education prior to September 1, 2009."

- **The process updates cost of SOQ and other Direct Aid accounts by reconstructing costs step-by-step using latest data available to recognize changes in costs that have occurred over the preceding biennium.**

- **Costs are projected forward for anticipated enrollment changes, inflation, and other factors.**

Rebenchmarking Process

- Process applies to the Standards of Quality, Incentive, Categorical, and Lottery Funded accounts.
- Funding for SOQ programs is determined primarily by instructional staffing ratios and recognized support costs that are funded on a standard and prevailing cost basis.
- Incentive programs are voluntary and provide additional education funding that goes beyond the levels required to meet the Standards of Quality.
- Categorical programs are generally required by state or federal statutes or federal regulation and target particular needs of specific populations.
- Lottery funding supports additional programs that go beyond the Standards of Quality and includes several programs formerly in the Incentive category.

Rebenchmarking Process

- SOQ accounts represent approximately 91 percent of state Direct Aid funding so they are impacted most by the rebenchmarking process.

- Seven key components of the SOQ funding formula:

  1) Number of students
  2) Staffing ratios for teachers and other funded positions
  3) Salaries of teachers and other funded positions
  4) Fringe benefit rates
  5) Standard and prevailing support costs
  6) Inflation factors
  7) Prevailing federal revenues related to support costs

Rebenchmarking Process

- **Major data elements used in 2010-2012 rebenchmarking calculations:**
  - **Funded instructional and support salaries**
  - **Fall Membership and Average Daily Membership projections**
  - **Special education child count**
  - **Career & Technical Education course enrollment**
  - **SOL failure rates and free lunch eligibility percentage for remedial education**
  - **Base-year expenditure data from 2007-2008 Annual School Report**
  - **Health care premium expenditures**
  - **Nonpersonal inflation factors**
  - **Federal programs revenue**
  - **Prevailing textbooks costs**
  - **Enrollment projections for remedial summer school and English as a Second Language programs**
  - **Updates to division superintendent, school board, school nurse, and pupil transportation costs**

Rebenchmarking Process

Major Inputs that are Fixed for the Biennium:

- Funded Salaries
- Special Education Child Counts
- Original Fall Membership & ADM Projections
- CTE Course Enrollment
- Composite Index
- Head Start Enrollment (for VPI)
- Free Lunch Eligibility Percentage
- SOL Test Scores (for Prevention, Intervention, and Remediation)
- Federal Revenue Deduct (for Support Costs)

Major Inputs that are Updated Annually:

- Enrollment Projections
- Reimbursement Account Projections
- Lottery Revenue Estimates
- Sales Tax Revenue Estimates
- VRS Fringe Benefit Rates (subject to General Assembly action)
- Inflation Factors (subject to General Assembly action)

Rebenchmarking Process

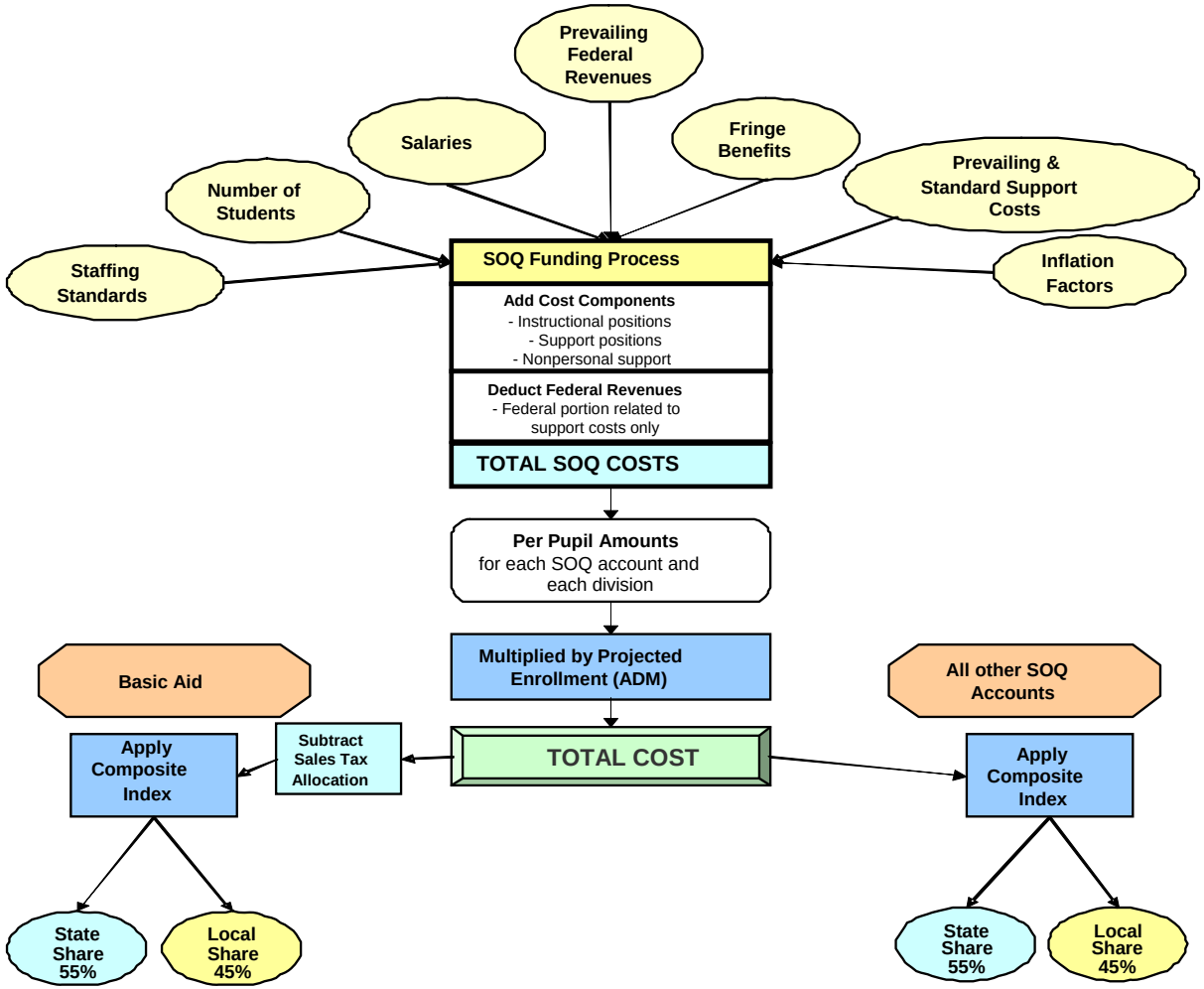
2010-2012 Direct Aid to Public Education Budget
Summary of Major Data Elements Used in 2010-2012 Rebenchmarking Calculations

	FY 2010	FY 2011 & FY2012
A. Student Enrollment Data		
Fall Membership	2006-2007	2008-2009
Special Education Child Count	December 1, 2006	December 1, 2008
Vocational Education Child Count	2006-2007	2008-2009
SOQ Prevention, Intervention and Remediation *(SOL English & Math Test Scores)*	Three-year average (2003-04; 2004-05; 2005-06)	Three-year average (2005-06; 2006-07; 2007-08)
SOQ Prevention, Intervention and Remediation *(Free Lunch Eligibility Data)*	Three-year average (October 2004, 2005, 2006)	Three-year average (October 2006, 2007, 2008)
B. Expenditure Data (funded salaries and support costs)	2005-2006 Annual School Report	2007-2008 Annual School Report
C. Fringe Benefit Rates		
Instructional VRS Retirement (Including Retiree Health Care Credit)	9.85%	9.85% (Update in Fall 2009)
Non-instructional VRS Retirement	7.62%	7.62% (Update in Fall 2009)
Social Security/Medicare	7.65%	7.65%
Group Life Insurance	0.27%	0.27% (Update in Fall 2009)
Health Care Premium *(Funded per position amount with Inflation)*	$5,188	$5,793
D. Composite Index *(Base-Year Data)*	2005	2007 (Update in Fall 2009)
E. Funded Non-Personal Support Inflation Factors *(Unweighted average)*	5.39%	0.52%
F. Textbooks *(Funded Per Pupil Amount with Inflation)*	$118.52	$76.01
G. Average Daily Membership Projections *(Original)*	1,203,367 (FY 2010)	1,212,501 (FY 2011), 1,221,831 (FY 2012)

Rebenchmarking Process

- **The following data inputs are not available for the Board of Education budget but will be updated and included in the 2010-2012 budget as introduced by the Governor in December 2009:**
  - **Revised composite index for the 2010-2012 biennium**
  - **Final enrollment projections**
  - **Revised Lottery revenue projections**
  - **Revised sales tax revenue projections**
  - **Revised fringe benefit rates from VRS**
- **State cost of 2010-2012 rebenchmarking is significantly lower than for the 2008-2010 biennium.**

Rebenchmarking Process for SOQ



2010-2012 Rebenchmarking Costs

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
1	Reset Support Personal Inflation Factors to 0% in SOQ Model	(29,271,364)	(29,271,364)	(58,542,728)
2	Update Fall Membership and Average Daily Membership	43,034,347	46,626,632	89,660,979
3	Update Special Education Child Count to December 1, 2008	(15,359,977)	(15,354,703)	(30,714,680)
4	Update Career & Technical Education Course Enrollment to Beginning School Year 2008	886,468	811,315	1,697,783
5	Update SOQ Remediation SOL Test Scores and Free Lunch Percentage	730,062	859,664	1,589,726
6	Update SOQ Gifted, Support Technology, and Instructional Technology Positions	(523,374)	(399,281)	(922,655)
7	Update SOQ Funded Instructional Salaries	(17,519,246)	(17,506,159)	(35,025,405)
8	Update Health Care Premium (without inflation)	35,332,715	35,504,569	70,837,284
9	Update Prevailing Textbook Per Pupil Amount (without inflation)	(25,199,060)	(25,268,945)	(50,468,005)

2010-2012 Rebenchmarking Costs

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
10	Reset Nonpersonal Inflation Factors to 0% in SOQ Model	(64,712,946)	(64,712,946)	(129,425,892)
11	Update Base-Year Expenditures (ASRFIN) for Support Personal Costs to FY08	52,512,011	52,768,217	105,280,228
12	Update Base-Year Expenditures (ASRFIN) for Support Nonpersonal Costs to FY08	38,874,888	35,313,121	74,188,009
13	Update Support Positions Cap	(12,452,565)	(12,885,798)	(25,338,363)
14	Update Federal Revenue Deduct Per Pupil Amount	2,177,284	2,130,997	4,308,281
15	Update Pupil Transportation Costs	33,907,430	46,632,633	80,540,063
16	Update Costs for Superintendents, School Boards, and School Nurses (w/o inflation)	5,781,638	5,578,808	11,360,446
17	Update Nonpersonal Inflation Factors	8,078,551	8,048,194	16,126,745
18	Update Personal Inflation Factors	0	0	0

2010-2012 Rebenchmarking Costs

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
19	Update English as a Second Language Enrollment Projections	2,813,877	5,934,217	8,748,094
20	Update Remedial Summer School Per Pupil Amount and Enrollment Projections	44,967	545,811	590,778
21	Update Incentive Accounts (See Appendix B for Account Listing)	695,170	1,045,760	1,740,930
22	Update Categorical Accounts (See Appendix B for Account Listing)	(95,277)	2,508,067	2,412,789
23	Update Lottery Funded Accounts (See Appendix A for Account Listing)	0	0	0
Total Rebenchmarking State Cost *(with support cap)**		**$59,735,599**	**$78,908,809**	**$138,644,408**
24	Remove Support Positions Funding Cap	$376,075,632	$378,226,051	$754,301,683
Total Rebenchmarking State Cost *(without support cap)**		**$435,811,231**	**$457,134,860**	**$892,946,091**

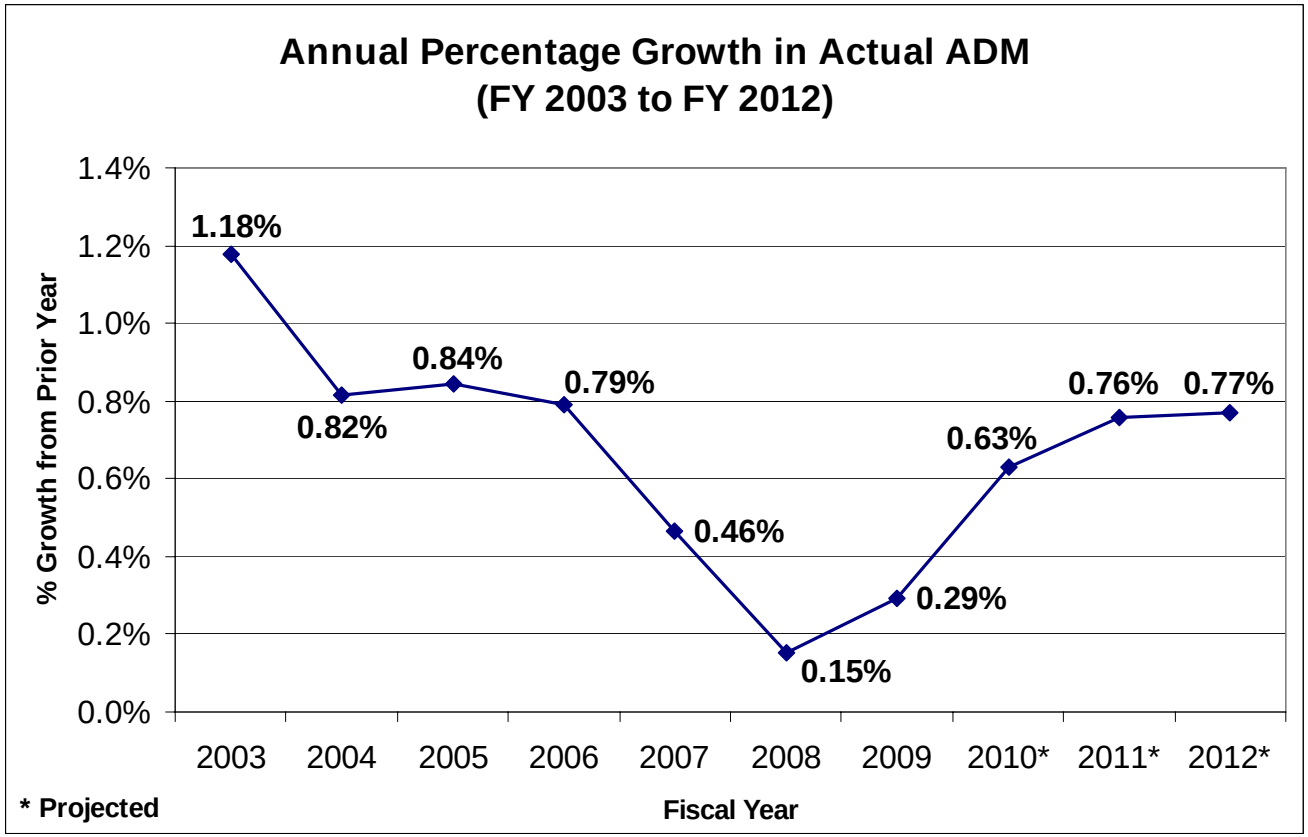
*** Pursuant to Item 140, paragraph C.5.k.2), Chapter 781, 2009 Acts of Assembly,** the Department of Education *"shall make its calculation for the total cost of rebenchmarking for the fiscal year 2010-2012 biennium to be consistent with the following methodologies: (i) using the 'support position funding cap' methodology change contained in House Bill 1600/Senate Bill 850, as introduced in the 2009 Session; and (ii) using the rebenchmarking methodology which was contained within Chapter 879, from the 2008 Session. The Department of Education shall report the final calculations and related costs derived from each of these methodologies to the Governor, the Chairmen of House Appropriations and Senate Finance Committees, and the Board of Education prior to September 1, 2009."*

Analysis of Key Data Inputs Impacting 2010-2012 Rebenchmarked Cost

- Enrollment
- Special Education Child Count
- SOL Failure Rates
- Free Lunch Eligibility
- Prevailing and Funded Salaries
- Health Care Premium
- Textbook Expenditures
- Support Position Cap
- Federal Revenue Deduct
- Inflation Factors

Enrollment

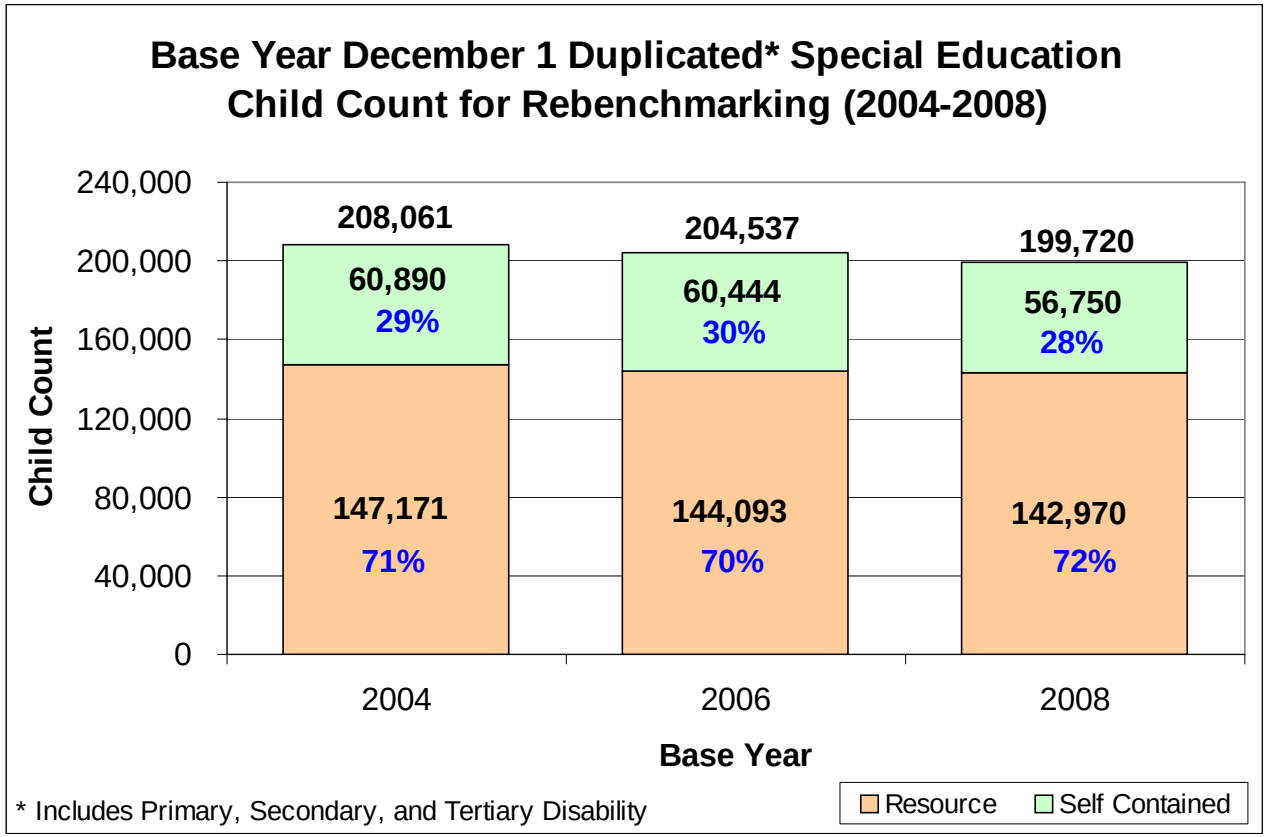
Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
2	Update Fall Membership and Average Daily Membership	43,034,347	46,626,632	89,660,979



VIRGINIA DEPARTMENT OF EDUCATION

Special Education Child Count

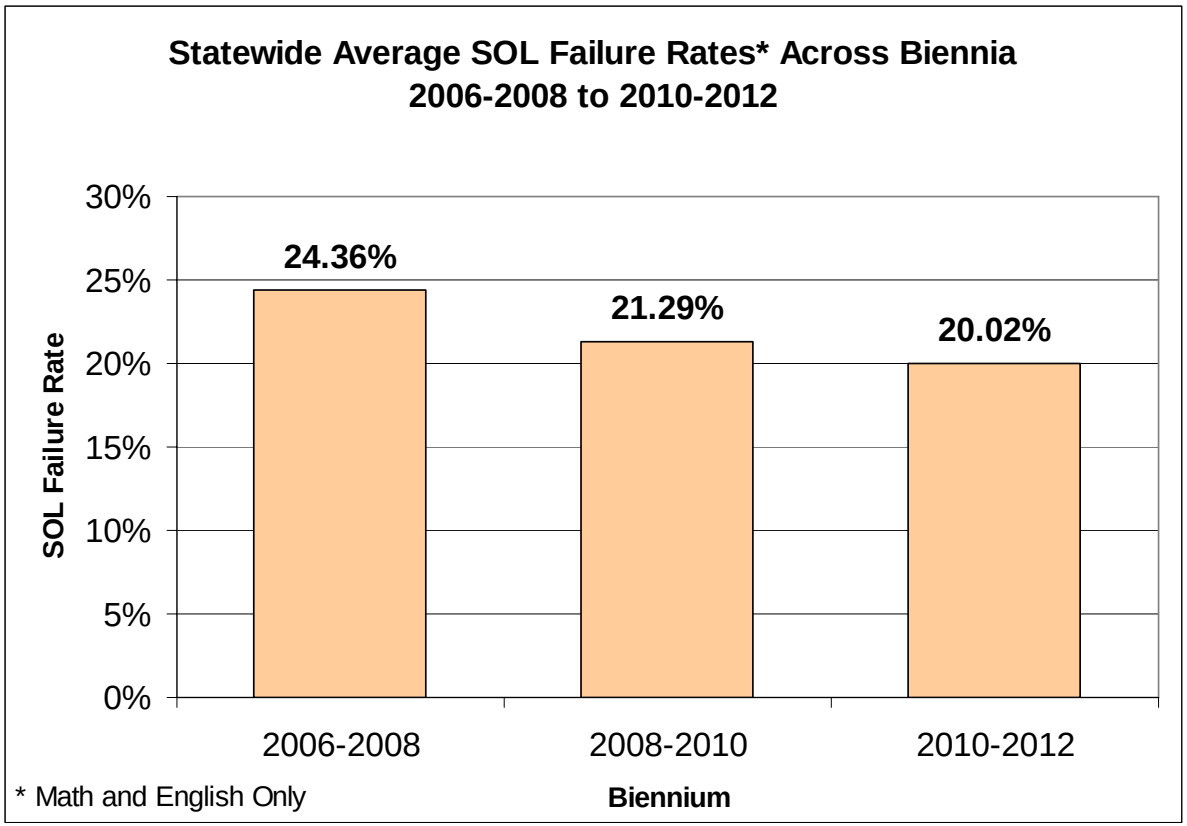
Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
3	Update Special Education Child Count to December 1, 2008	(15,359,977)	(15,354,703)	(30,714,680)



VIRGINIA DEPARTMENT OF EDUCATION

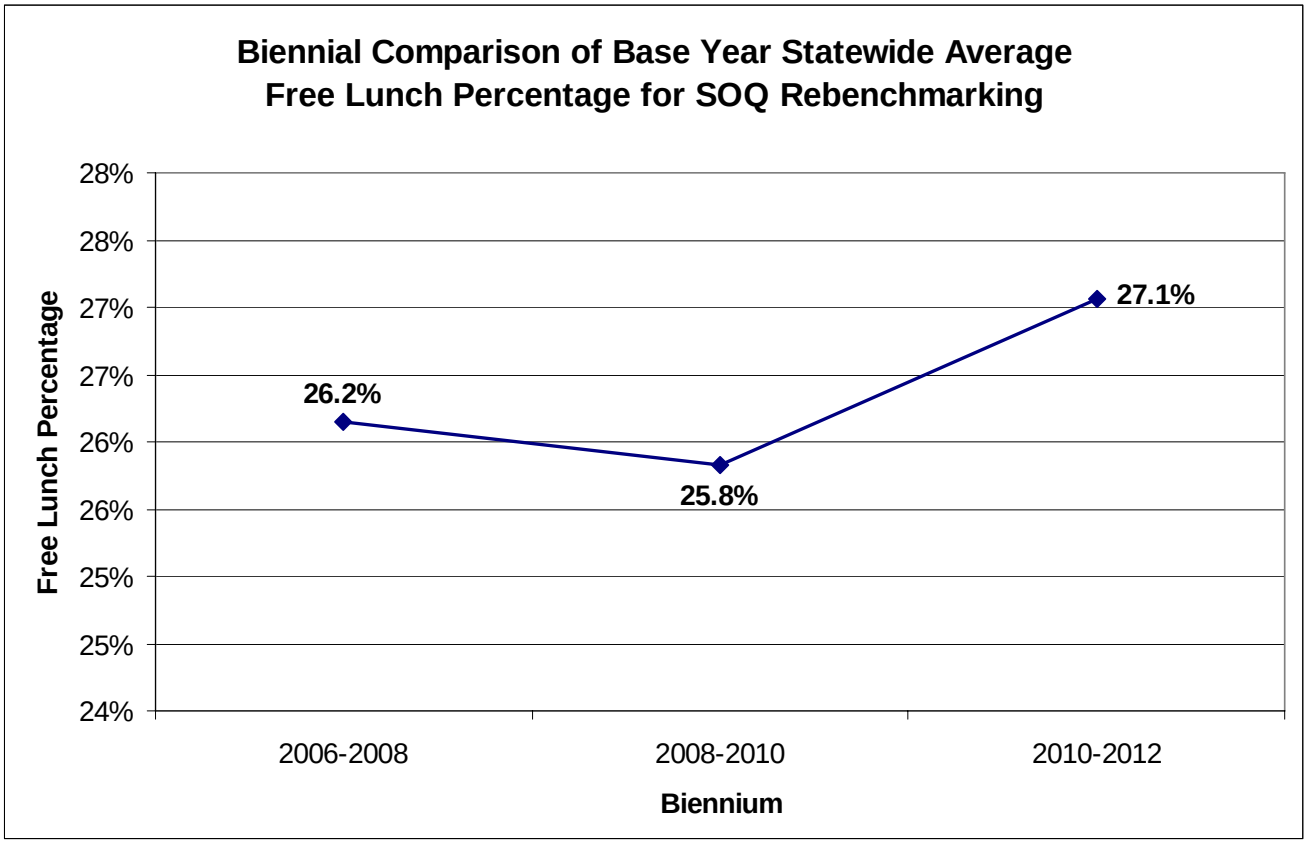
SOL Failure Rates

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
5	Update SOQ Remediation SOL Test Scores and Free Lunch Percentage	730,062	859,664	1,589,726



Free Lunch Eligibility

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
5	Update SOQ Remediation SOL Test Scores and Free Lunch Percentage	730,062	859,664	1,589,726



Instructional Salaries

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
7	Update SOQ Funded Instructional Salaries	(17,519,246)	(17,506,159)	(35,025,405)

Comparison of Prevailing SOQ Instructional Salaries Across Biennia
2006-2008 to 2010-2012 (No Adjustment for State Increases)

Instructional Position	2006-2008 Prevailing Salary (2003-04 Data)	2008-2010 Prevailing Salary (2005-06 Data)	Percent Increase	2008-2010 Prevailing Salary (2005-06 Data)	2010-2012 Prevailing Salary (2007-08 Data)	Percent Increase
Elementary Teachers	$38,525	$41,390	7.4%	$41,390	$43,904	6.1%
Elementary Asst. Principals	$54,201	$58,398	7.7%	$58,398	$62,383	6.8%
Elementary Principals	$66,817	$72,124	7.9%	$72,124	$76,766	6.4%
Secondary Teachers	$40,403	$43,158	6.8%	$43,158	$46,090	6.8%
Secondary Asst. Principals	$58,043	$62,460	7.6%	$62,460	$66,658	6.7%
Secondary Principals	$73,076	$78,721	7.7%	$78,721	$84,564	7.4%
Instructional Aides	$13,426	$14,820	10.4%	$14,820	$16,104	8.7%

Instructional Salaries

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
7	Update SOQ Funded Instructional Salaries	(17,519,246)	(17,506,159)	(35,025,405)

Comparison of Funded SOQ Instructional Salaries Across Biennia
2004-2006 to 2010-2012 (Adjusted for State Increases)

Instructional Position	2004-2006 FUNDED SALARY	2006-2008 FUNDED SALARY	Percent Increase	2006-2008 FUNDED SALARY	2008-2010 FUNDED SALARY	Percent Increase	2008-2010 FUNDED SALARY	2010-2012 FUNDED SALARY	Percent Increase
Elementary Teachers	$37,534	$39,681	5.7%	$39,681	$44,337	11.7%	$44,337	$43,904	(1.0%)
Elementary Asst. Principals	$52,546	$55,827	6.2%	$55,827	$62,556	12.1%	$62,556	$62,383	(0.3%)
Elementary Principals	$64,562	$68,822	6.6%	$68,822	$77,259	12.3%	$77,259	$76,766	(0.6%)
Secondary Teachers	$39,641	$41,615	5.0%	$41,615	$46,230	11.1%	$46,230	$46,090	(0.3%)
Secondary Asst. Principals	$57,365	$59,784	4.2%	$59,784	$66,907	11.9%	$66,907	$66,658	(0.4%)
Secondary Principals	$70,945	$75,268	6.1%	$75,268	$84,326	12.0%	$84,326	$84,564	0.3%
Instructional Aides	$12,802	$13,828	8.0%	$13,828	$15,875	14.8%	$15,875	$16,104	1.4%

Support Salaries

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
11	Update Base-Year Expenditures (ASRFIN) for Support Personal Costs to FY08	52,512,011	52,768,217	105,280,228

Comparison of Prevailing SOQ Support Salaries Across Biennia 2006-2008 to 2010-2012 (No Adjustment for State Increases)

Support Position	2006-2008 Salary	2008-2010 Salary	Percent Increase	2008-2010 Salary	2010-2012 Salary	Percent Increase
Superintendent	$108,113	$120,166	11.15%	$120,166	$132,141	9.97%
Assistant Superintendent	$91,948	$98,878	7.54%	$98,878	$106,021	7.22%
School Nurse	$29,198	$31,261	7.06%	$31,261	$33,378	6.77%
Instructional Professional	$56,637	$59,910	5.78%	$59,910	$64,105	7.00%
Instructional Technical/Clerical	$23,300	$25,763	10.57%	$25,763	$28,232	9.58%
A&H Administrative	$46,062	$49,543	7.56%	$49,543	$54,139	9.28%
A&H Technical//Clerical	$21,357	$22,422	4.99%	$22,422	$24,558	9.53%
O&M Professional	$56,647	$61,899	9.27%	$61,899	$67,823	9.57%
O&M Technical/Clerical	$22,681	$24,451	7.81%	$24,451	$26,888	9.97%
School Board Member	$3,453	$4,134	19.72%	$4,134	$4,639	12.21%
Administration Administrative	$62,967	$64,420	2.31%	$64,420	$68,991	7.10%
Administration Technical/Clerical	$31,560	$34,275	8.60%	$34,275	$36,629	6.87%
Technology Professional	$59,242	$63,397	7.01%	$63,397	$68,808	8.54%
Technology Technical/Clerical	$26,655	$27,968	4.92%	$27,968	$30,411	8.74%
Technology Support Standard	$33,590	$35,439	5.51%	$35,439	$39,705	12.04%
School Based Clerical	$23,383	$24,857	6.30%	$24,857	$29,092	17.04%

Support Salaries

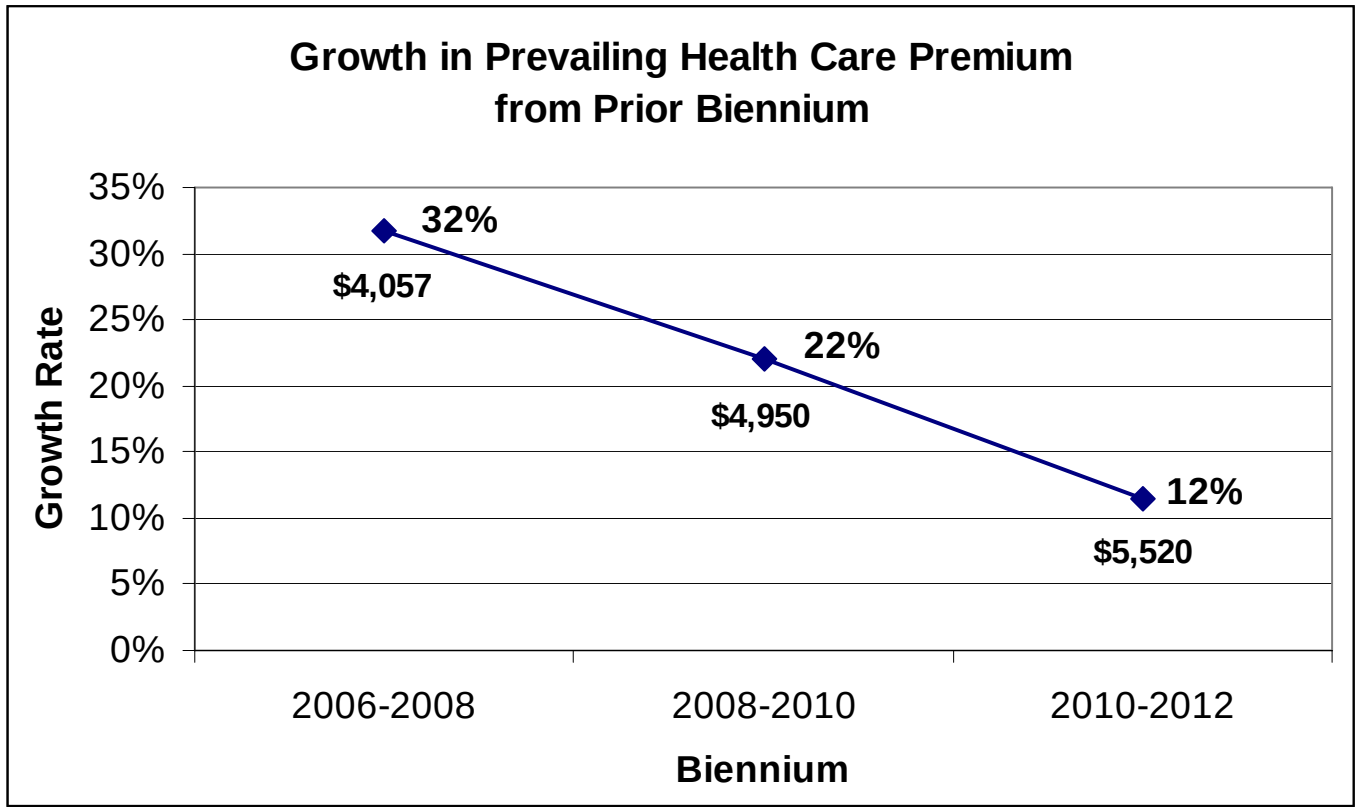
Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
11	Update Base-Year Expenditures (ASRFIN) for Support Personal Costs to FY08	52,512,011	52,768,217	105,280,228

Comparison of Funded SOQ Support Salaries Across Biennia
2006-2008 to 2010-2012 (Adjusted for State Increases)

Support Position	2006-2008 Salary	2008-2010 Salary	Percent Increase	2008-2010 Salary	2010-2012 Salary	Percent Increase
Superintendent	$111,356	$127,484	14.48%	$127,484	$132,141	3.65%
Assistant Superintendent	$94,706	$104,900	10.76%	$104,900	$106,021	1.07%
School Nurse	$30,074	$33,165	10.28%	$33,165	$33,378	0.64%
Instructional Professional	$58,336	$63,558	8.95%	$63,558	$64,105	0.86%
Instructional Technical/Clerical	$23,999	$27,332	13.89%	$27,332	$28,232	3.29%
A&H Administrative	$47,444	$52,560	10.78%	$52,560	$54,139	3.00%
A&H Technical//Clerical	$21,998	$23,788	8.14%	$23,788	$24,558	3.24%
O&M Professional	$58,346	$65,668	12.55%	$65,668	$67,823	3.28%
O&M Technical/Clerical	$23,361	$25,940	11.04%	$25,940	$26,888	3.65%
School Board Member	$3,557	$4,386	23.31%	$4,386	$4,639	5.77%
Administration Administrative	$64,856	$68,343	5.38%	$68,343	$68,991	0.95%
Administration Technical/Clerical	$32,506	$36,362	11.86%	$36,362	$36,629	0.73%
Technology Professional	$61,019	$67,258	10.22%	$67,258	$68,808	2.31%
Technology Technical/Clerical	$27,455	$29,671	8.07%	$29,671	$30,411	2.49%
Technology Support Standard	$34,597	$37,598	8.67%	$37,598	$39,705	5.60%
School Based Clerical	$24,084	$26,371	9.49%	$26,371	$29,092	10.32%

Health Care Premium

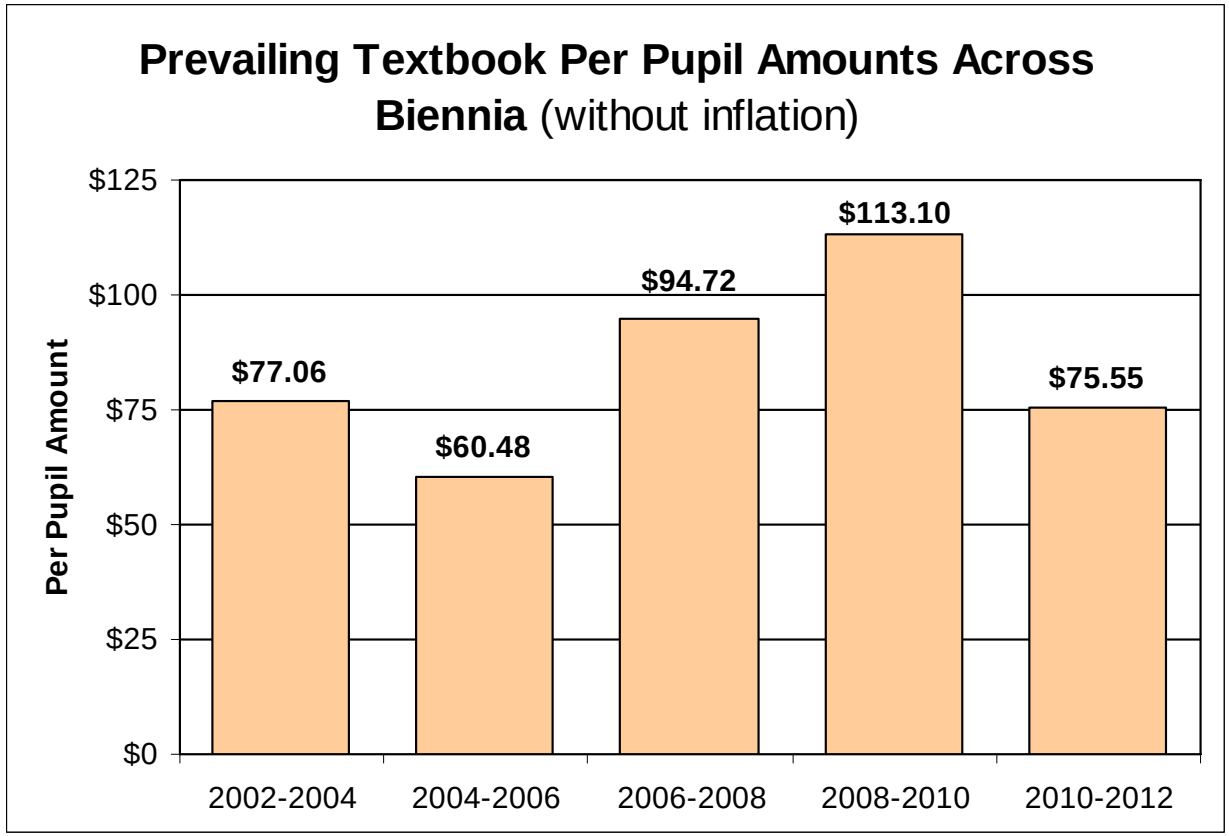
Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
8	Update Health Care Premium (without inflation)	35,332,715	35,504,569	70,837,284



VIRGINIA DEPARTMENT OF EDUCATION

Textbook Expenditures

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
9	Update Prevailing Textbook Per Pupil Amount (without inflation)	(25,199,060)	(25,268,945)	(50,468,005)



Support Positions Cap

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
13	Update Support Positions Cap	(12,452,565)	(12,885,798)	(25,338,363)

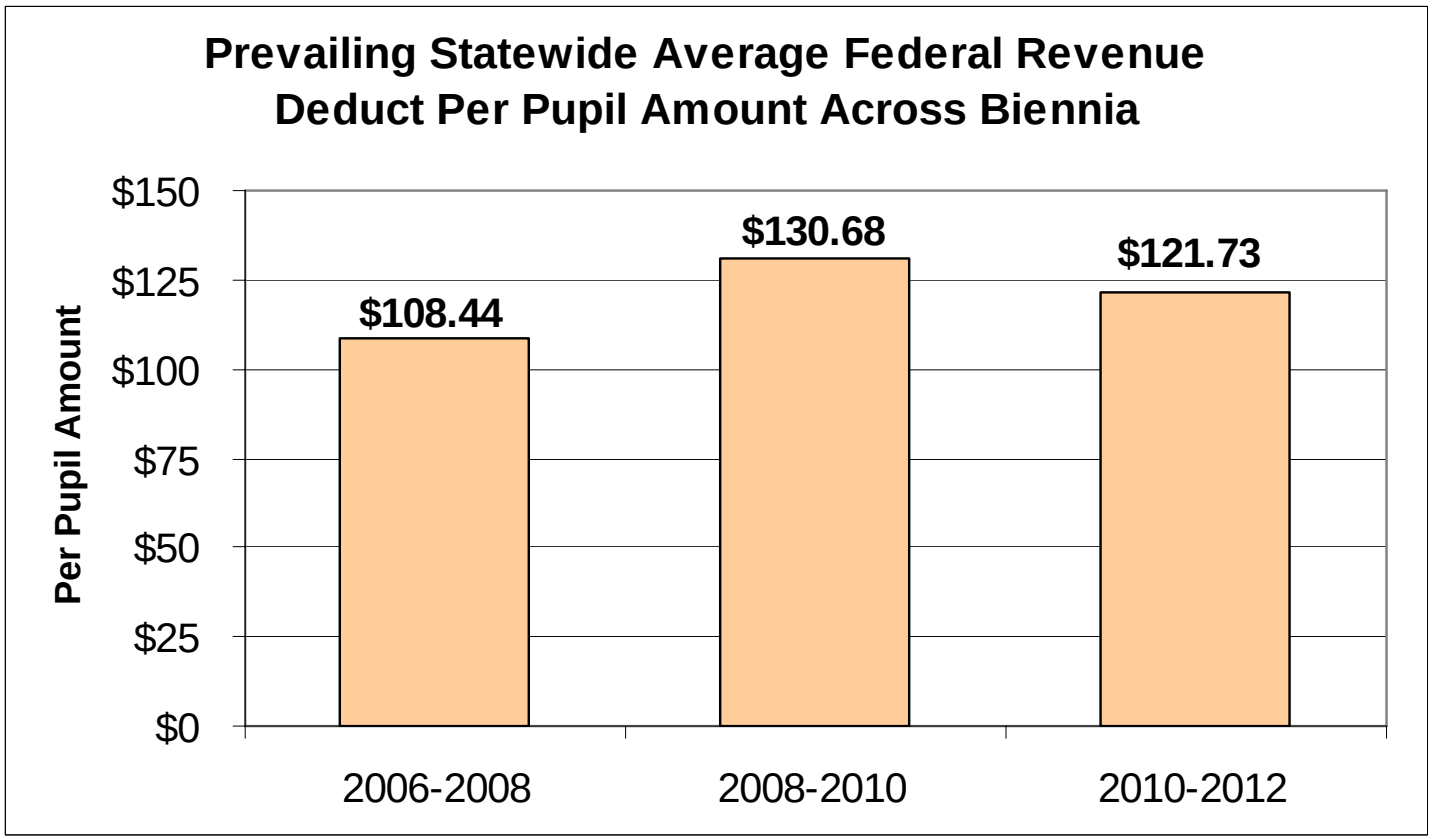
Funded SOQ Support Positions	UNCAPPED FY 2009	CAPPED FY 2010	CAPPED FY 2011	CAPPED FY 2012
Assistant Superintendent	292	183	175	176
Instructional Professional	3,474	2,175	2,138	2,152
Instructional Technical/Clerical	2,912	1,824	1,882	1,895
Attendance & Health Administrative	1,628	1,019	995	1,002
Attendance & Health Technical/Clerical	753	470	519	523
Operation & Maintenance Professional	428	269	251	252
Operation & Maintenance Technical/Clerical	14,305	8,957	8,689	8,746
Administration	859	538	587	590
Administration Technical/Clerical	2,486	1,556	1,513	1,524
Technology Professional	579	362	376	379
Technology Technical/Clerical	292	183	194	195
Technology Support Standard	1,208	1,219	1,211	1,221
School Based Clerical	6,479	4,056	3,652	3,675
Total Funded SOQ Support Positions	**35,695**	**22,811**	**22,181**	**22,329**

[1] For FY 2009, the prevailing number of support positions was not capped. Shown for comparative purposes.

[2] The instructional to support position ratio used for the support position funding cap was rebenchmarked for the 2010-2012 biennium. The ratio changed from 4.03 to 1 for FY 2010 to 4.05 to 1 for the 2010-2012 biennium. The ratio is calculated by taking a three-year average of divisions' ASR instructional positions divided by ASR support positions and then calculating a statewide linear weighted average (LWA) ratio from the division ratios. The LWA ratio is then applied to the generated number of support positions to cap them at the instructional to support ratio. This represents the rebenchmarked cost update and not a permanent change in policy.

Federal Revenue Deduct

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
14	Update Federal Revenue Deduct Per Pupil Amount	2,177,284	2,130,997	4,308,281



Inflation Factors

Step #	Rebenchmarking Step	FY 2011 Change	FY 2012 Change	2010-2012 Total
17	Update Nonpersonal Inflation Factors	8,078,551	8,048,194	16,126,745

2010-2012 Inflation Factors Applied to Nonpersonal Costs in SOQ Model for the 2010-2012 Biennium			
Inflation Factor	**2008-10 Rates**	**2010-12 Rates**	**Variance**
Operation & Maintenance:			
Utilities	3.34%	(6.43%)	(9.77%)
Communications	5.67%	2.39%	(3.28%)
Insurance	5.56%	0.61%	(4.95%)
Other	5.56%	0.61%	(4.95%)
Fixed Charges:			
Unemployment	5.56%	0.61%	(4.95%)
Workers Comp.	5.56%	0.61%	(4.95%)
Disability Insurance	5.56%	0.61%	(4.95%)
Other Benefits	5.56%	0.61%	(4.95%)
Instructional:			
Classroom Instruction	5.48%	0.36%	(5.12%)
Instructional Support	5.48%	0.31%	(5.17%)
Improvement	5.31%	(0.01%)	(5.32%)
Principal's Office	5.44%	0.26%	(5.18%)
Miscellaneous:			
Administration	5.40%	0.11%	(5.29%)
Attendance & Health	5.46%	0.34%	(5.12%)
Facilities	5.62%	2.73%	(2.89%)
Pupil Transportation	5.11%	(0.19%)	(5.30%)
Contingency Reserve	5.56%	0.61%	(4.95%)
Textbooks	5.56%	0.61%	(4.95%)
Health Care Premium	5.56%	4.96%	(0.60%)

Rebenchmarking Summary

Major Inputs that Decreased Cost Compared to 2008-2010 Biennium:

- Funded Instructional Salaries
- Funded Support Salaries
- Special Education Child Counts
- Statewide Average SOL Failure Rate
- Inflation Factors
- Health Care Premium
- Textbook Expenditures

Major Inputs that Increased Cost Compared to 2008-2010 Biennium:

- CTE Course Enrollment
- Enrollment Projections
- Free Lunch Eligibility
- Federal Revenue Deduct Per Pupil Amount
- Pupil Transportation

Board of Education Agenda Item

Item: E. **Date:** October 22, 2009

Topic: First Review of a Revised Memorandum of Understanding for Petersburg City Public Schools to Include Compliance with the *Regulations Establishing Standards for Accrediting Public Schools in Virginia* (SOA) 8 VAC 20-131-315

Presenter: Dr. Kathleen M. Smith, Director, Office of School Improvement, Division of Student Assessment and School Improvement
Dr. James M. Victory, Superintendent, Petersburg City Public Schools

Telephone Number: (804) 225-2865 **E-Mail Address:** Kathleen.Smith@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

__X__ Board review required by
____ State or federal law or regulation
_X__ Board of Education regulation
____ Other: _____

____ Action requested at this meeting __X_ Action requested at future meeting: November 20, 2009

Previous Review/Action:

____ No previous board review/action

_X__ Previous review/action
date April 30, 2009

Background Information:

The Standards of Quality require local school boards to maintain fully accredited schools and to take corrective actions for schools that are not fully accredited.

> § 22.1-253.13:3**.** Standard 3. Accreditation, other standards and evaluation.
>
> …Each local school board shall maintain schools that are fully accredited pursuant to the standards of accreditation as prescribed by the Board of Education. Each local school board shall review the accreditation status of all schools in the local school division annually in public session. Within the time specified by the Board of Education, each school board shall submit corrective action plans for any schools within its school division that have been designated as not meeting the standards as approved by the Board.

In October 2004, the Virginia Board of Education (VBOE) established criteria for identifying low-performing school divisions to undergo a division-level academic review. Petersburg City Public Schools met the criteria for division-level academic review.

> § 22.1-253.13:3. Standard 3. Accreditation, other standards and evaluation**.**
>
> …When the Board of Education has obtained evidence through the school academic review process that the failure of schools within a division to achieve full accreditation status is related to division level failure to implement the Standards of Quality, the Board may require a division level academic review. After the conduct of such review and within the time specified by the Board of Education, each school board shall submit for approval by the Board a corrective action plan, consistent with criteria established by the Board and setting forth specific actions and a schedule designed to ensure that schools within its school division achieve full accreditation status. Such corrective action plans shall be part of the relevant school division's comprehensive plan pursuant to § 22.1-253.13:6.

In 2004, recognizing the need for technical assistance, the Petersburg City School Board requested a division-level review and assistance from the Virginia Department of Education (VDOE). Petersburg City Public Schools and the VBOE signed an initial Memorandum of Understanding (MOU) detailing the review process on April 21, 2004.

Based on 2005-2006 assessment results and the resulting accreditation and federal adequate yearly progress (AYP) ratings of the division and its schools, Petersburg City Public Schools entered into a second MOU on November 20, 2006. The proposed MOU with the VBOE required Petersburg City Public Schools to continue in division-level academic review status and participate in an academic review process prescribed by the VBOE.

In the November 2006 MOU, the Petersburg City School Board and central office staff adopted five key priorities for improving student achievement across the school division, ensuring alignment of resources with these priorities for improving student achievement, and holding the board and staff accountable for results. The key priorities included:

- Student Achievement
- Leadership Capacity
- Teacher Quality
- Communication with all Stakeholders
- Safe and Secure Environment

As part of the November 2006 MOU, an efficiency review was completed on January 10, 2007, by MGT of America, Inc. Ninety (90) recommendations were indicated, 38 of which were accompanied by fiscal implications. According to the review, full implementation of the recommendations would generate a total savings of $34,620,950 over a five-year period. Petersburg City Public Schools has provided periodic updates regarding the implementation of the efficiency review.

As required by the November 2006 MOU, the VBOE and the VDOE assigned a chief academic officer (CAO) to work with the superintendent and administrative staff to coordinate and monitor the implementation of processes, procedures, and strategies associated with the corrective action plan

resulting from the MOU. The CAO coordinated with VDOE offices to provide technical assistance in support of the MOU and corrective action plan. The CAO had administrative authority over processes, procedures, and strategies that are implemented in support of the MOU and funded by targeted federal and state funds with subsequent review and approval by the Petersburg City School Board.

As a result of the collaborative efforts of the superintendent, administrative staff and the CAO, Petersburg City Public Schools has four of its seven schools fully accredited for the 2009-2010 school year: Robert E. Lee Elementary School, Walnut Hill Elementary School, A. P. Hill Elementary School, and Petersburg High School. Four of six Title I schools remain in school improvement. The history of each school's accreditation and Adequate Yearly Progress (AYP) status is indicated in Attachment A.

In 2008-2009, Petersburg City Public Schools restructured their middle and high school grades. Peabody Middle School and Vernon Johns Middle School moved from grades 6-8 to grades 6-7 and grades 8-9, respectively. Petersburg High school moved from grades 9-12 to grades 10-12. The rating in the 2009-2010 year provided in the data above is based on the assessment data from the previous year of the new grade configuration. The aggregated data for each grade level for English and mathematics in the division over the past five year period is provided in Attachment A.

Another area of concern addressed in the November 2006 MOU was the limited number of highly-qualified teachers employed by the division as well as the number of teachers who were provisionally licensed and the number of long-term substitutes employed as teachers in core content areas. Hard-to-staff funding was provided in the first two years of the MOU; however, results presented at the Senate Finance Committee on December 6, 2007, demonstrated little improvement in the number of provisional or unlicensed teachers employed by the division. On September 23, 2008, Petersburg City Public Schools reported that of the 399 teachers employed in 2008-2009, 393 (98 percent) were licensed; five teachers were not teaching in endorsed areas; 61 (15 percent) were new teachers; and six teachers were indicated as long-term substitutes.

The November 2006 MOU specified that a contingency plan be developed if the schools did not meet school accreditation targets:

> *The Petersburg School Board, Virginia Board of Education, and the Department of Education will develop a contingency plan for major restructuring to be in place for the 2007-2008 school year if significant improvements in student achievement and school accreditation do not occur for the 2006-2007 school year. The decision to begin the planning for restructuring will be based on reports provided by Petersburg Public Schools to both the Virginia Board of Education and department staff as well as recommendations made by the CAO throughout the year.*

Although the development of the contingency restructuring plan was implemented one year later than planned in the November 2006 MOU, a committee of outside experts from universities, community-based organizations working in Petersburg, the CAO, and department staff met during the 2007-2008 year after assessments given in 2006-2007 resulted in the school division not meeting accountability goals of the MOU for two consecutive years. This committee developed an instructional intervention to be led by an outside entity for middle school students and parents (by choice of entry into the intervention) to begin in 2009-2010.

This plan was based in part on the work of Mass Insight Education and the concept of a turnaround zone. The committee agreed that the plan should include an outside partner to develop and implement a comprehensive "school within a school" model for middle grade students. The committee presented this plan at the June 18, 2008, meeting of the Virginia Board of Education, School and Division Accountability Committee. This plan met the following conditions agreed upon by the VBOE and Petersburg City Public Schools:

1. Alternative governance.
2. Choice option for middle school students and parents.
3. Research-based focus on core content.
4. Recruitment, selection, and supervision of highly qualified personnel by an independent entity.
5. Proven track record of educational success.

Federal school improvement funds that were allocated only to local education agencies (LEAs) with schools in improvement were available to cover the start-up costs for program development and implementation planning. On November 20, 2008, the VBOE requested that the Petersburg City School Board plan for the implementation of the contingency restructuring proposal in the 2009-2010 school year and authorized the VDOE to assist Petersburg City Public Schools in such planning by providing available federal resources. On April 30, 2009, Petersburg City Public Schools reported to the VBOE that a turnaround partner could not be secured. The VBOE requested that a vendor be selected no later than August 15, 2009, with implementation for students occurring no later than January 2010. At this time, no turnaround partner has been secured.

Summary of Major Elements

The November 2006 MOU specified target goals for three years ending after the 2008-2009 school year. Additionally, Section 8 VAC 20-131-300 of the *Regulations Establishing Standards for Accrediting Public Schools in Virginia* (SOA), adopted by the VBOE in July 2009, requires school divisions with *Accreditation Denied* schools to enter into a MOU with the VBOE and implement a corrective action plan to improve student achievement in the identified schools. Since Petersburg City Public Schools have schools in *Accreditation Denied* status for the 2009-2010 academic year based on 2008-2009 results, the MOU for division-level academic review will also serve as the MOU to satisfy Section 8 VAC 20-131-310. As a part of the proposed MOU, a corrective action plan must be developed. The proposed MOU will be in place until all schools are fully accredited.

For the purposes of the proposed MOU, the Petersburg City School Board and central office staff will adopt two key priorities: *leadership capacity* and *teacher quality*. The priorities will improve student achievement across the school division and must be aligned with resources.

The VBOE and the VDOE will continue to assign a CAO to work with the superintendent and administrative staff to develop, coordinate and monitor the implementation of processes, procedures, and strategies associated with the corrective action plan resulting from the proposed MOU. The CAO will coordinate with VDOE offices to provide technical assistance in support of the MOU and corrective action plan. The CAO will have administrative authority over processes, procedures, and strategies that are implemented in support of the MOU and funded by targeted federal and state funds with subsequent review and approval by the Petersburg City School Board.

Petersburg City Public Schools will provide the CAO with an office in the central administration office; telephone, computer, and printer access, and clerical support, as needed. Key administrative responsibilities are included in the proposed MOU:

Student Achievement

1. The central office leadership team under the direction of the CAO or designee will develop a consolidated federal application each year of the proposed MOU that complies with the findings of the efficiency review, focuses on improved student achievement, and connects strategies to the division's corrective action plan. The Petersburg City School Board will review and approve the consolidated federal application.

2. The central office leadership team under the direction of the CAO and Petersburg City School Board will develop and implement a corrective action plan that complies with the findings of the efficiency review, focuses on improved student achievement, and connects strategies to the full implementation of the algebra readiness and early reading initiatives.

3. The central office staff will provide monthly written reports on the implementation of the algebra readiness and early reading initiatives to include activities planned, activities completed, timelines, participation targets and requests for reimbursement to the CAO and the Petersburg City School Board.

4. The central office will work with school staff to implement effective corrective action plans for all schools that are in *Accreditation Denied* status and No Child Left Behind (NCLB) restructuring. The corrective action plans must meet the requirements of NCLB and the Standards of Accreditation (SOA) and be aligned with the division's key strategies for improved student achievement. Corrective action plans must be approved by the Petersburg City School Board, VBOE and VDOE. Additionally, progress reports on implementing the plans will be shared quarterly with these entities.

5. The central office will work with VDOE staff and the CAO to identify one or more external turnaround partners for the implementation of a specific restructuring plan that meets the requirements of NCLB for all schools in restructuring under NCLB and is approved by the VDOE.

Leadership Capacity

Petersburg City Public Schools will implement an accountability system that links leadership of both the school and the division to student achievement data and provides professional development to improve student achievement. Petersburg City Public Schools will demonstrate commitment to hiring school and division staff with a proven record of increasing student achievement.

Teacher Quality

The central office leadership team under the direction of the CAO or designee will develop and monitor individual action plans to reduce the incidence of teachers with provisional licenses. Petersburg City Public Schools will commit to hiring personnel who are the most qualified for the position vacancy and have a proven track record of increasing student achievement. A report for Petersburg City Public Schools indicating the progress in hiring highly qualified staff for 2009-2010 is included as

Attachment B.

Petersburg City Public Schools will provide written reports as requested by the CAO (as needed and appropriate) on current instructional vacancies, number of teachers with provisional licenses, and progress on individual action plans to reach full licensure to the VBOE and VDOE.

As a part of the proposed MOU, the Petersburg City School Board will continue to provide summative reports on progress made in meeting or exceeding MOU agreements and expectations to the VBOE and VDOE, as requested.

Superintendent's Recommendation:
The Superintendent of Public Instruction recommends that the Board of Education accept for first review the attached revised Memorandum of Understanding (MOU) for Petersburg City Public Schools.

Impact on Resources: None

Timetable for Further Review/Action: The proposed MOU will be submitted to the Board of Education for final review on November 20, 2009.

Attachment A

VIRGINIA BOARD OF EDUCATION
PETERSBURG CITY SCHOOL BOARD

MEMORANDUM OF UNDERSTANDING
Goals and Expected Outcomes

Background

The Standards of Quality require local school boards to maintain fully accredited schools and to take corrective actions for schools that are not fully accredited.

> § 22.1-253.13:3**.** Standard 3. Accreditation, other standards and evaluation.
>
> …Each local school board shall maintain schools that are fully accredited pursuant to the standards of accreditation as prescribed by the Board of Education. Each local school board shall review the accreditation status of all schools in the local school division annually in public session. Within the time specified by the Board of Education, each school board shall submit corrective action plans for any schools within its school division that have been designated as not meeting the standards as approved by the Board.

In October 2004, the Virginia Board of Education (VBOE) established criteria for identifying low-performing school divisions to undergo a division-level academic review. Petersburg City Public Schools met the criteria for division-level academic review.

> § 22.1-253.13:3. Standard 3. Accreditation, other standards and evaluation**.**
>
> …When the Board of Education has obtained evidence through the school academic review process that the failure of schools within a division to achieve full accreditation status is related to division level failure to implement the Standards of Quality, the Board may require a division level academic review. After the conduct of such review and within the time specified by the Board of Education, each school board shall submit for approval by the Board a corrective action plan, consistent with criteria established by the Board and setting forth specific actions and a schedule designed to ensure that schools within its school division achieve full accreditation status. Such corrective action plans shall be part of the relevant school division's comprehensive plan pursuant to § 22.1-253.13:6.

In 2004, recognizing the need for technical assistance, the Petersburg City School Board requested a division-level review and assistance from the Virginia Department of Education (VDOE). Petersburg City Public Schools and the VBOE signed an initial Memorandum of Understanding (MOU) detailing the review process on April 21, 2004.

Based on 2005-2006 assessment results and the resulting accreditation and federal adequate yearly progress (AYP) ratings of the division and its schools, Petersburg City Public Schools entered into a second MOU on November 20, 2006. This MOU with the VBOE required Petersburg City Public Schools to continue in division-level academic review status and participate in an academic review

process prescribed by the VBOE.

In the November 2006 MOU, the Petersburg City School Board and central office staff adopted five key priorities for improving student achievement across the school division, ensuring alignment of resources with these priorities for improving student achievement, and holding the board and staff accountable for results. The key priorities included:

- Student Achievement
- Leadership Capacity
- Teacher Quality
- Communication with all Stakeholders
- Safe and Secure Environment

As part of the November 2006 MOU, an efficiency review was completed on January 10, 2007, by MGT of America, Inc. Ninety (90) recommendations were indicated, 38 of which were accompanied by fiscal implications. According to the review, full implementation of the recommendations would generate a total savings of $34,620,950 over a five-year period. Petersburg City Public Schools has provided periodic updates regarding the implementation of the efficiency review.

As required by the November 2006 MOU, the VBOE and the VDOE assigned a chief academic officer (CAO) to work with the superintendent and administrative staff to coordinate and monitor the implementation of processes, procedures, and strategies associated with the corrective action plan resulting from the MOU. The CAO coordinated with VDOE offices to provide technical assistance in support of the MOU and corrective action plan. The CAO had administrative authority over processes, procedures, and strategies that were implemented in support of the MOU and funded by targeted federal and state funds with subsequent review and approval by the Petersburg City School Board.

As a result of the collaborative efforts of the superintendent, administrative staff and the CAO, Petersburg City Public Schools has four of its seven schools fully accredited for the 2009-2010 school year: Robert E. Lee Elementary School, Walnut Hill Elementary School, A. P. Hill Elementary School, and Petersburg High School. Four of six Title I schools remain in school improvement. The history of each school's accreditation and Adequate Yearly Progress (AYP) status is indicated as follows:

A. P. Hill Elementary School

Adequate Yearly Progress (AYP) Pass Rates	2006	2007	2008	2009
English Performance	54.32	58.79	61.47	80.66
Mathematics Performance	48.75	64.20	63.68	80.16
Science Performance	44.12	58.06	61.83	74.03
History Performance		66.92	60.61	81.17
Did or Did not Make AYP	Did Not Make AYP	Did Not Make AYP Year 1 of Improvement	Did Not Make AYP Year 2 of Improvement	Made AYP Year 2 Holding of Improvement-Holding
Accreditation Status	Warned	Denied	Denied	Fully Accredited

J.E.B. Stuart Elementary

Adequate Yearly Progress (AYP) Pass Rates	2006	2007	2008	2009
English Performance	63.80	65.66	69.03	75.94
Mathematics Performance	62.58	50.3	73.25	64.02
Science Performance	67.59	62.62	68.24	58.65
History Performance		67.52	75.86	88.65
Did or Did not Make AYP	Did Not Make AYP Year 3 of Improvement	Did Not Make AYP Year 4 of Improvement	Did Not Make AYP Year 5 of Improvement	Did Not Make AYP Year 5 Holding of Improvement
Accreditation Status	Warned	Denied	Denied	Denied

Robert E. Lee Elementary

Adequate Yearly Progress (AYP) Pass Rates	2006	2007	2008	2009
English Performance	66.67	79.25	77.84	81.01
Mathematics Performance	64.76	84.91	77.01	83.05
Science Performance	69.33	76.71	75.42	88.39
History Performance		81.33	75.86	89.91
Did or Did not Make AYP	Made AYP	Made AYP	Made AYP	Made AYP
Accreditation Status	Warned	Fully Accredited	Fully Accredited	Fully Accredited

Walnut Hill Elementary

Adequate Yearly Progress (AYP) Pass Rates	2006	2007	2008	2009
English Performance	77.92	76.62	64.08	85.19
Mathematics Performance	77.92	76.51	72.08	81.19
Science Performance	71.24	73.44	70.33	73.11
History Performance		74.51	59.22	84.62
Did or Did not Make AYP	Made AYP	Made AYP	Made AYP	Made AYP
Accreditation Status	Warned	Fully Accredited	Accredited with Warning	Fully Accredited

Peabody Middle

Adequate Yearly Progress (AYP) Pass Rates	2006	2007	2008	2009
English Performance	46.25	45.15	51.78	64.17
Mathematics Performance	25.17	28.38	40.67	46.72
Science Performance	62.92	62.38	66.46	
History Performance		34.59	45.65	62.78
Did or Did not Make AYP	Did Not Make AYP Year 3 of School Improvement	Did Not Make AYP Year 4 of School Improvement	Did Not Make AYP Year 5 of School Improvement	Did Not Make AYP Year 5 Holding of School Improvement
Accreditation Status	Warned	Denied	Denied	Denied
Assessment data based on grade levels	6-8	6-8	6-8	6-7

Vernon Johns Middle School/Junior High

Adequate Yearly Progress (AYP) Pass Rates	2006	2007	2008	2009
English Performance	53.64	55.82	58.14	62.06
Mathematics Performance	34.44	39.08	50.31	88.87
Science Performance	62.77	73.99	71.10	68.23
History Performance		46.68	58.05	69.93
Did or Did not Make AYP	Did Not Make AYP Year 5 of School Improvement	Did Not Make AYP Year 6 of School Improvement	Did Not Make AYP Year 7 of School Improvement	Did Not Make AYP Year 7 Holding of School Improvement
Accreditation Status	Warned	Denied	Denied	Denied
Assessment data based on grade levels	6-8	6-8	6-8	8-9

Petersburg High School

Adequate Yearly Progress (AYP) Pass Rates	2006	2007	2008	2009
English Performance	75.64	76.01	87.06	90.10
Mathematics Performance	41.99	49.54	68.61	85.95
Science Performance	53.28	60.50	63.60	83.59
History Performance	53.28	60.50	63.60	83.59
Did or Did not Make AYP	Did Not Make AYP Year 3 of School Improvement	Did Not Make AYP Year 4 of School Improvement	Did Not Make AYP Year 5 of School Improvement	Did Not Make AYP Year 5 of School Improvement
Title I Status	Not a Title I School	Not a Title I School	Not a Title I School	Not a Title I School
Accreditation Status	Accreditation Denied	Accreditation Denied	Accreditation Denied	Fully Accredited
Assessment data based on grade levels	9-12	9-12	9-12	10-12

In 2008-2009, Petersburg City Public Schools restructured their middle and high school grades. Peabody Middle School and Vernon Johns Middle School moved from grades 6-8 to grades 6-7 and grades 8-9, respectively. Petersburg High school moved from grades 9-12 to grades 10-12. The rating in the 2009-2010 year provided in the data above is based on the assessment data from the previous year for the new grade configuration. The aggregated data for each grade level for English and mathematics in the division over the past five year period is provided below:

Petersburg City Public Schools - English

Test Level	SOL Test	2004-2005 Passed	2004-2005 Attempted	2004-2005 Pct Passed	2005-2006 Passed	2005-2006 Attempted	2005-20065 Pct Passed	2006-2007 Passed	2006-2007 Attempted	2006-2007 Pct Passed	2007-2008 Passed	2007-2008 Attempted	2007-2008 Pct Passed	2008-2009 Passed	2008-2009 Attempted	2008-2009 Pct Passed
3	English Reading	214	354	60.45	200	312	64.1	217	350	62	229	349	65.62	266	337	78.93
4	English Reading				234	348	67.24	240	304	78.95	240	336	71.43	238	322	73.91
5	English Reading	238	369	64.5	190	313	60.7	232	347	66.86	190	279	68.1	275	321	85.67
6	English Reading				203	382	53.14	168	326	51.53	176	317	55.52	161	265	60.75
7	English Reading				184	350	52.57	187	349	53.58	145	311	46.62	191	298	64.09
8	English Reading	162	415	39.04	161	408	39.46	167	395	42.28	195	349	55.87	175	285	61.4
11	English Reading	191	297	64.31	266	329	80.85	244	309	78.96	250	288	86.81	273	304	89.8

Petersburg City Public Schools - Mathematics

Test Level	SOL Test	2004-2005 Passed	2004-2005 Attempted	2004-2005 Pct Passed	2005-2006 Passed	2005-2006 Attempted	2005-20065 Pct Passed	2006-2007 Passed	2006-2007 Attempted	2006-2007 Pct Passed	2007-2008 Passed	2007-2008 Attempted	2007-2008 Pct Passed	2008-2009 Passed	2008-2009 Attempted	2008-2009 Pct Passed
3	Mathematics	259	353	73.37	230	310	74.19	246	355	69.3	245	349	70.2	253	337	75.07
4	Mathematics				197	347	56.77	194	302	64.24	221	336	65.77	247	322	76.71
5	Mathematics	222	369	60.16	189	309	61.17	240	347	69.16	180	279	64.52	241	318	75.79
6	Mathematics				65	385	16.88	50	306	16.34	106	283	37.46	99	214	46.26
7	Mathematics				33	363	9.09	57	346	16.47	68	299	22.74	104	290	35.86
8	Mathematics	193	423	45.63	192	372	51.61	194	387	50.13	195	338	57.69	235	288	81.6
11	Algebra I	196	330	59.39	246	437	56.29	237	293	80.89	300	352	85.23	448	478	93.72
11	Algebra II	67	189	35.45	74	143	51.75	104	216	48.15	134	210	63.81	74	87	85.06
11	Geometry	74	232	31.9	85	305	27.87	138	388	35.57	78	166	46.99	128	158	81.01

Additionally, Section 8 VAC 20-131-300 of the *Regulations Establishing Standards for Accrediting Public Schools in Virginia* (SOA), adopted by the VBOE in July 2009, requires school divisions with *Accreditation Denied* schools to enter into a MOU with the VBOE and implement a corrective action plan to improve student achievement in the identified schools. Since Petersburg City Public Schools have schools in *Accreditation Denied* status for the 2009-2010 academic year based on 2008-2009 results, the MOU for division-level academic review will also serve as the MOU to satisfy Section 8 VAC 20-131-310. As a part of this MOU, a corrective action plan must be developed.

Another area of concern addressed in the November 2006 MOU was the limited number of highly-qualified teachers employed by the division as well as the number of teachers who were provisionally licensed and the number of long-term substitutes employed as teachers in core content areas. Hard-to-staff funding was provided in the first two years of the MOU; however, results presented at the Senate Finance Committee on December 6, 2007, demonstrated little improvement in the number of provisional or unlicensed teachers employed by the division. On September 23, 2008, Petersburg City Public Schools reported that of the 399 teachers employed in 2008-2009, 393 (98 percent) were licensed; five teachers were not teaching in endorsed areas; 61 (15 percent) were new teachers; and six teachers were indicated as long-term substitutes.

The November 2006 MOU specified that a contingency plan be developed if the schools did not meet school accreditation targets:

> *The Petersburg School Board, Virginia Board of Education, and the Department of Education will develop a contingency plan for major restructuring to be in place for the 2007-2008 school year if significant improvements in student achievement and school accreditation do not occur for the 2006-2007 school year. The decision to begin the planning for restructuring will be based on reports provided by Petersburg Public Schools to both the Virginia Board of Education and department staff as well as recommendations made by the CAO throughout the year.*

Although the development of the contingency restructuring plan was implemented one year later than planned in the November 2006 MOU, a committee of outside experts from universities, community-based organizations working in Petersburg, the CAO, and department staff met during the 2007-2008 year after assessments given in 2006-2007 resulted in the school division not meeting accountability goals of the MOU for two consecutive years. This committee developed an instructional intervention to be led by an outside entity for middle school students and parents (by choice of entry into the intervention) to begin in 2009-2010.

This plan was based in part on the work of Mass Insight Education and the concept of a turnaround zone. The committee agreed that the plan should include an outside partner to develop and implement a comprehensive "school within a school" model for middle grade students. The committee presented this plan at the June 18, 2008, meeting of the School and Division Accountability Committee. This plan met the following conditions agreed upon by the VBOE and Petersburg City Public Schools:

1. Alternative governance.
2. Choice option for middle school students and parents.
3. Research-based focus on core content.
4. Recruitment, selection, and supervision of highly qualified personnel by an independent entity.
5. Proven track record of educational success.

Federal school improvement funds that were allocated only to local education agencies (LEAs) with schools in improvement were available to cover the start-up costs for program development and implementation planning. On November 20, 2008, the VBOE requested that the Petersburg City School Board plan for the implementation of the contingency restructuring proposal in the 2009-2010 school year and authorized the VDOE to assist Petersburg City Public Schools in such planning by providing available federal resources. On April 30, 2009, Petersburg City Schools reported to the VBOE that a vendor could not be secured. The VBOE requested that a turnaround partner be selected no later than August 15, 2009, with implementation for students occurring no later than January 2010. At this time, no turnaround partner has been selected.

School Division Goals and Performance Objectives

For the purposes of this MOU, the Petersburg City School Board and central office staff will adopt two key priorities: *leadership capacity* and *teacher quality*. The priorities will improve student achievement across the school division and must be aligned with resources.

This MOU will be in place until all schools are fully accredited.

Assignment of a Chief Academic Officer (CAO) to Petersburg Public Schools

The VBOE and the VDOE will continue to assign a CAO to work with the superintendent and administrative staff to develop, coordinate and monitor the implementation of processes, procedures, and strategies associated with the corrective action plan resulting from this MOU. The CAO will coordinate with VDOE offices to provide technical assistance in support of the MOU and corrective action plan. The CAO will have administrative authority over processes, procedures, and strategies that are implemented in support of the MOU and funded by targeted federal and state funds with subsequent review and approval by the Petersburg City School Board.

Petersburg City Public Schools will provide the CAO with an office in the central administration office; telephone, computer, and printer access, and clerical support, as needed.

Key Administrative Responsibilities

<u>Student Achievement</u>

1. The central office leadership team under the direction of the CAO or designee will develop a consolidated federal application each year of this MOU that complies with the findings of the efficiency review, focuses on improved student achievement, and connects strategies to the division's corrective action plan. The Petersburg City School Board will review and approve the consolidated federal application.

2. The central office leadership team under the direction of the CAO and Petersburg City School Board will develop and implement a corrective action plan that complies with the findings of the efficiency review, focuses on improved student achievement, and connects strategies to the full implementation of the algebra readiness and early reading initiatives.

3. The central office staff will provide monthly written reports on the implementation of the algebra readiness and early reading initiatives to include activities planned, activities completed, timelines, participation targets and requests for reimbursement to the CAO and the Petersburg City School Board.

4. The central office will work with school staff to implement effective corrective action plans for all schools that are in *Accreditation Denied* status and No Child Left Behind (NCLB) restructuring. The corrective action plans must meet the requirements of NCLB and the Standards of Accreditation (SOA) and be aligned with the division's key strategies for improved student achievement. Corrective action plans must be approved by the Petersburg City School Board, VBOE and VDOE. Additionally, progress reports on implementing the plans will be shared quarterly with these entities.

5. The central office will work with VDOE staff and the CAO to identify one or more external turnaround partner for the implementation of a specific restructuring plan that meets the requirements of NCLB for all schools in restructuring under NCLB and is approved by the VDOE.

Leadership Capacity

Petersburg City Public Schools will implement an accountability system that links leadership of both the school and the division to student achievement data and provides professional development to improve student achievement. Petersburg City Public Schools will demonstrate commitment to hiring school and division staff with a proven record of increasing student achievement.

Teacher Quality

The central office leadership team under the direction of the CAO or designee will develop and monitor individual action plans to reduce the incidence of teachers with provisional licenses. Petersburg City Public Schools will commit to hiring personnel who are the most qualified for the position vacancy and have a proven track record of increasing student achievement.

Petersburg City Public Schools will provide written reports as requested by the CAO (as needed and appropriate) on current instructional vacancies, number of teachers with provisional licenses, and progress on individual action plans to reach full licensure to the VBOE and VDOE.

Status Reports to the Virginia Board of Education

The Petersburg City School Board will provide a summative report on progress made in meeting or exceeding MOU agreements and expectations to the VBOE and VDOE, as requested.

Authorizations

I (We) agree to work collaboratively to implement the requirements of the Memorandum of Understanding (MOU) for the purpose of improving student achievement in Petersburg City Public Schools.

Printed Name: _____ **Title: Chair, Petersburg City School Board** **Signature:** _____ **Date:** _____	**Printed Name:** _____ **Title: Superintendent, Petersburg City Public Schools** **Signature:** _____ **Date:** _____
Printed Name: _____ **Title: President, Virginia Board of Education** **Signature:** _____ **Date:** _____	**Printed Name:** _____ **Title: Superintendent of Public Instruction** **Signature:** _____ **Date:** _____

Attachment B

PETERSBURG CITY PUBLIC SCHOOLS

Teacher Profile

Description	SY2005-06	SY2006-07	SY2007-08	SY2008-09	(Sept) SY2009-10
Number of Teachers	424	429	422	399	376
Licensed Teachers	396 = 93.4%	415 = 96.7%	401 = 95%	393 = 98%	376 = 100%
Unlicensed Teachers	28 = 6.6%	14 = 3.3%	21 = 5%	2	0
Number of Teachers Designated as Substitutes	18	20	20	6	5
Substitutes Unlicensed	11	12	16	6	4
New Teachers	54= 12.7%	47 = 11%	36 = 8.5%	61 = 15%	29 = 7.7%
Number Of Title I Teachers	199	199	185	163	167
Highly Qualified Professional Development	100%	100%	100%	100%	100%
Highly Qualified Teachers	83.60%	90.7%	86.7%	85%	98%
Average Years Teaching Experience	11.7	11.6	12.4	12.2	12.8%
Teacher Turnover	128 = 29.4%	92 = 21.7%	116 = 27%	67 = 17%	36 = 9%
Post Graduate Degrees	~	~	~	~	
Masters	124	138	144	133	124
Juris Doctorate	1	1	1	1	1
Education Sp.	0	0	0	0	0
Doctorate	2	3	1	1	4

Board of Education Agenda Item

Item: F. **Date:** October 22, 2009

Topic: First Review of a Report on Career and Technical Education Programs in Petersburg City Public Schools

Presenter: Dr. Kathleen M. Smith, Director, Office of School Improvement, Division of Student Assessment and School Improvement
Dr. James M. Victory, Superintendent, Petersburg City Public Schools

Telephone Number: (804) 225-2865 **E-Mail Address:** Kathleen.Smith@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

____ Board review required by
- ____ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

____ Action requested at this meeting ____ Action requested at future meeting: _____

Previous Review/Action:

____ No previous board review/action

_X_ Previous review/action
date May 28, 2009
action Board requested additional information regarding the Career and Technical Education programs in Petersburg City Public Schools

Background Information:

The Standards of Quality require local school boards to maintain fully accredited schools and to take corrective actions for schools that are not fully accredited.

§ 22.1-253.13:3. Standard 3. Accreditation, other standards and evaluation.

…Each local school board shall maintain schools that are fully accredited pursuant to the standards of accreditation as prescribed by the Board of Education. Each local school board shall review the accreditation status of all schools in the local school division annually in public session. Within the time specified by the Board of Education, each school board shall submit corrective action plans for any schools within its school division that have been designated as not meeting the standards as approved by the Board.

In October 2004, the Virginia Board of Education (VBOE) established criteria for identifying low-performing school divisions to undergo a division-level academic review. Petersburg City Public Schools met the criteria for division-level academic review as indicated in Section 22.1-253.13:.3. Standard 3. Accreditation, other standards and evaluation:

> …*When the Board of Education has obtained evidence through the school academic review process that the failure of schools within a division to achieve full accreditation status is related to division level failure to implement the Standards of Quality, the Board may require a division level academic review. After the conduct of such review and within the time specified by the Board of Education, each school board shall submit for approval by the Board a corrective action plan, consistent with criteria established by the Board and setting forth specific actions and a schedule designed to ensure that schools within its school division achieve full accreditation status. Such corrective action plans shall be part of the relevant school division's comprehensive plan pursuant to Section 22.1-253.13:6.*

In 2004, recognizing the need for technical assistance, the Petersburg School Board requested a division- level review and assistance from the Virginia Department of Education (VDOE). Petersburg City Public Schools and the VBOE signed an initial memorandum of understanding (MOU) detailing the review process on April 21, 2004. Petersburg City Public Schools has been in division-level review status since 2004 and has reported to the VBOE regularly on the status of implementing the corrective action plan and the terms of the initial MOU. The VDOE has provided ongoing technical assistance and monitored the implementation of the division's corrective action plan.

Additionally, the *Regulations Establishing Standards for Accrediting Public Schools in Virginia* (SOA) require school divisions with *Accreditation Denied* schools to enter into a MOU with the VBOE and implement a corrective action plan to improve student achievement in the identified schools. Since Petersburg City Public Schools had schools in *Accreditation Denied* status for the 2007-2008 academic year based on 2006-2007 results, the VBOE determined that the MOU for division-level academic review would also serve as the MOU to satisfy Section 8 VAC 20-131-310. As a part of this MOU, a corrective action plan was developed.

The MOU requires the Petersburg School Board to provide a summative report on progress made in meeting or exceeding the MOU agreements and expectations to the VBOE and the VDOE, as requested. At the April 23, 2008, meeting of the Virginia Board of Education, School and Division Accountability Committee, members of the committee requested information on the following:

1. the number of students enrolled in alternative education programs and their status in these programs;
2. the number of students enrolled in the Individual Student Alternative Education Plan (ISAEP); and,
3. the number of unlicensed teachers (substitute teachers) by core content area in which they are teaching.

At the May 21, 2008, Virginia Board of Education meeting, a report containing the requested information was presented by department staff. At this time, the VBOE requested that a follow-up review be completed in the fall of 2008 to determine if the alternative education programs in Petersburg City Public Schools including the ISAEP program were in compliance with the Standards of Quality and the Standards of Accreditation.

The department conducted an academic review of the alternative programs in Petersburg City Public Schools on December 11-12, 2008. The review team consisted of VDOE staff and peer reviewers from other school divisions. The following essential actions were presented to Petersburg City Schools as part of the December 11-12, 2008 review:

- Align Horizons Program curriculum with skills necessary for transition to programs leading to a standard or advanced studies diploma or to a GED (ISAEP) program.
- Adhere to procedures for student placement that allow for parent input and are conducted in a timely manner.
- Secure the needed resources and materials for students and teachers (i.e., textbooks).
- Provide access to the Career and Technical Education (CTE) programs to the students enrolled in the Career Preparedness Program (CPP).
- Provide early intervention in elementary and middle school programs to reduce the need for alternative programs.

One of the concerns of the review team was that the CTE courses provided to students enrolled in the CPP program would not lead to a program completion upon graduation. For example, students are enrolled in Landscaping (course code 8036). There are other courses needed for a program concentration in Landscaping that lead to program completion upon graduation. These courses are not offered at Blandford Academy.

The CPP program provides high school students, age 16 or older and at least two grade-levels behind, with an opportunity to work toward successfully meeting the criteria for a certificate of completion, not a traditional or nontraditional diploma (GED).

At the January 15, 2009, Virginia Board of Education meeting, the Board accepted the findings of the review of alternative education programs in Petersburg City Public Schools and requested the department to complete a follow-up visit in the spring of 2009 to ensure that essential actions were being implemented.

The VDOE conducted a third review of the alternative programs in Petersburg City Public Schools on March 30, 2009, and as a result of that review, the following findings regarding Career and Technical Education at Blandford Academy were indicated:

<u>Provide access to the Career and Technical Education (CTE) programs to the students enrolled in the CPP program</u>. Interviews with students and teachers revealed that ISAEP, Horizons, and CPP students participate in the CTE programs at the high school twice a week after school. These practices were implemented during the start of the second semester of the 2008-2009 school year. These programs do not offer a program concentration that leads to program completion upon graduation. Two orientation programs for parents of Blandford Academy students were conducted to introduce the seven course offerings for the CTE program at Petersburg High School.

At the time of the review on March 30, 2009, current enrollment of ISAEP, Horizons, and CPP students who were participating in the CTE program after school at Petersburg High School were as follows:

- three students were enrolled in the carpentry program (one additional student was scheduled to begin on March 30, 2009);

- three students are enrolled in the child-care program (three additional students were scheduled to begin on March 30, 2009);
- two students were scheduled to begin the personal care aide program beginning on March 30, 2009;
- one student was scheduled to begin in the automotive program on March 30, 2009; and,
- one student was enrolled in the culinary arts program.

At the May 28, 2009, Virginia Board of Education meeting, the Board accepted the findings of the review of alternative education programs in Petersburg City Public Schools and requested the department to complete a follow-up visit in the fall of 2009 to ensure that CPP students are receiving certified CTE courses as described in the essential actions based on the follow-up review.

Summary of Major Elements

In a report submitted by Petersburg City Public Schools regarding the Blandford Academy students enrolled in CTE courses offered at Petersburg High School for the fall of 2009, the following data were indicated:

Course Code	Description	Number of Students Enrolled
8600	Basic Carpentry	1
8709	Auto Maintenance	1
8250	Introduction to Culinary Arts	6
8234	Introduction to Early Childhood Education	1
8511	Basic Masonry	3*
8403	Technology Foundations	7
8161	Hotel/Motel Services	5
8542	Computer Networking	3
TOTAL		26

*One student is completing an internship as a barber and is counted in Basic Masonry as well.

Superintendent's Recommendation
The Superintendent of Public Instruction recommends that the Board of Education waive first review and accept the report from Petersburg City Public Schools on the enrollment of Blandford Academy students in CTE programs at Petersburg High School.

Impact on Resources: None

Timetable for Further Review/Action: None

Attachment A

Petersburg City Public Schools
BLANDFORD ACADEMY
CAREER PREPAREDNESS PROGRAM (CPP) STUDENTS
CAREER AND TECHNICAL EDUCATION (CTE) ENROLLMENT AT PETERSBURG HIGH SCHOOL (PHS)
All Classes @ Block 2 at PHS – 9:00 a.m. to 10:30 a.m.

	Enrolled CPP Students	Home School	Last Grade Assigned	CTE Class @ PHS	Course Code	Teacher ID
	1	VJJH	9	Basic Carpentry	8600	105274
	2	VJJH	9	Auto Maintenance	8709	102873
	3	VJJH	9	Intro. Culinary Arts	8250	101247
	4	VJJH	9	Technology Foundation	8403	105026
	5	VJJH	9	Intro. Culinary Arts	8250	101247
	6	VJJH	9	Intro. Culinary Arts	8403	101247
	7	VJJH	9	Intro. Culinary Arts	8403	101247
	8	VJJH	9	Intro. Early Childhood Education	8234	102245
	9	VJJH	9	Technology Foundation	8403	105026
	10	VJJH	9	Basic Masonry	8511	102795
	11	VJJH	9	Intro. Culinary Arts	8250	101247
	12	VJJH	9	Technology Foundation	8403	105026
	13	VJJH	9	Intro. Culinary Arts	8403	101247
	CPP Students	**Home School**	**Last Grade Assigned**	**CTE Class @ PHS**	**Course Code**	**Teacher ID**
	14	VJJH	9	**Basic Masonry & Internship @Allusions Barber Shop**	8511	102795
	15	VJJH	9	Basic Masonry	8511	102795
	16	VJJH	9	Technology Foundations	8403	105026
	17	VJJH	10	Technology Foundations	8403	105026
	18	VJJH	9	Technology Foundations	8403	105026
	19	VJJH	9	Hotel/Motel	8161	101062
	20	PHS	10	Computer Network	8542	102269
	21	PHS	10	Hotel/Motel	8161	101062
	22	PHS	9	Hotel/Motel	8161	101062
	23	VJJH	9	Hotel/Motel	8161	101062
	24	VJJH	9	Computer Network	8542	102269
	25	VJJH	9	Computer Network	8542	102269
	26	VJJH	9	Technology Foundations	8403	105026
	27	VJJH	9	Hotel/Motel	8161	101062

Board of Education Agenda Item

Item: G. **Date:** October 22, 2009

Topic: First Review of the Advisory Board on Teacher Education and Licensure's Recommendation Regarding the Certification of Braille Instructors in Response to the Virginia General Assembly House Bill 2224

Presenter: Mrs. Patty S. Pitts, Assistant Superintendent for Teacher Education and Licensure

Telephone Number: (804) 371-2522 **E-Mail Address:** Patty.Pitts@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

___ Action requested at this meeting ____ Action requested at future meeting: _____ (date)

Previous Review/Action:

_X_ No previous board review/action

____ Previous review/action
date _____
action _____

Background Information:

The 2009 Virginia General Assembly enacted the following House Bill 2224, Chapter 202, regarding Braille certification:

> *§ 1. That by December 31, 2009, the Advisory Board on Teacher Education and Licensure, in consultation with the Department for the Blind and Vision Impaired, shall make recommendations to the Board of Education and the Chairmen of the House Committee on Education and the Senate Committee on Education and Health regarding the certification of Braille instructors.*

In consultation with the Department for the Blind and Vision Impaired, the Advisory Board on Teacher Education and Licensure (ABTEL) began discussions regarding Braille instruction, certification, and licensure. On March 16, 2009, the Advisory Board received a presentation from Mrs. Anne Wescott, assistant superintendent, Division of Policy and Communications, Virginia

Department of Education, on the proposed Braille legislation. On April 20, 2009, ABTEL received additional background information from Mrs. Patty Pitts, assistant superintendent for teacher education and licensure, Virginia Department of Education, and Mr. Glen Slonneger, education services program director, Department for the Blind and Vision Impaired. During the April 20, 2009, meeting, the Advisory Board approved a committee to research the policy issues and make recommendations to the full Advisory Board.

ABTEL's committee on Braille convened July 8 and August 5, 2009. At the meeting on August 5, 2009, Dr. Edward C. Bell, director of the Professional Development and Research Institute on Blindness, Louisiana Technology University, and Mr. Michael Kasey, National Federation of the Blind, met with the committee to present information on The National Literary Braille Competency Test.

The Advisory Board on Teacher Education and Licensure met on September 20-21, 2009, to review the committee's report and make a recommendation to the Board of Education. The Advisory Board received the report of the committee including research on Braille instruction, authority regarding Braille instruction, licensure assessments, the current teacher work force with endorsements in visual impairments, Virginia's consortium to prepare teachers of visual impairments, requirements of other states, and available Braille assessments.

Summary of Major Elements:

Attached is the Advisory Board on Teacher Education and Licensure's Report to the Board of Education on the 2009 Virginia General Assembly House Bill 2224 Regarding Braille Certification. On September 20-21, 2009, the Advisory Board on Teacher Education and Licensure unanimously approved the following recommendation to the Board of Education:

> The Advisory Board unanimously recommends to the Board of Education that a reliable, valid, and legally defensible assessment available statewide (to be determined) demonstrating Braille proficiency prescribed by the Virginia Board of Education be required for individuals seeking an initial license with an endorsement in Special Education-Visual Impairments. [The Department of Education shall follow policies and procedures relative to the procurement of such an assessment.] Additionally, contingent upon available funding, opportunities for licensed teachers with the endorsement in Visual Impairments be afforded additional professional development in the teaching of Braille through the Virginia Department of Education and the Department for the Blind and Vision Impaired. The Advisory Board supports the Virginia Board of Education's efforts to include teachers of visual impairments in the *Standards of Quality* funding formula.

Superintendent's Recommendation:

The Superintendent of Public Instruction recommends that the Board of Education receive for first review the Advisory Board on Teacher Education and Licensure's recommendation on Braille certification in response to the 2009 Virginia General Assembly House Bill 2224.

Impact on Resources:

The cost for a Braille assessment, if prescribed by the Board of Education, would be incurred by the test taker seeking an initial license with an endorsement in visual impairments.

Timetable for Further Review/Action:

After final review by the Board of Education in November 2009, the recommendation will be forwarded to the Chairmen of the House Committee on Education and the Senate Committee on Education and Health by December 31. Additional work will be required prior to recommending a reliable, valid, and legally defensible assessment for individuals seeking an initial Virginia license with an endorsement in Special Education-Visual Impairments. The Department of Education personnel must follow laws, policies, and procedures relative to the procurement of an assessment.

ADVISORY BOARD ON TEACHER EDUCATION AND LICENSURE

REPORT TO THE BOARD OF EDUCATION
ON THE
2009 VIRGINIA GENERAL ASSEMBLY
HOUSE BILL 2224 REGARDING BRAILLE CERTIFICATION

October 22, 2009

Background

The 2009 Virginia General Assembly enacted the following House Bill 2224 regarding Braille:

VIRGINIA GENERAL ASSEMBLY, HOUSE BILL 2224

CHAPTER 202

An Act to direct the Advisory Board on Teacher Education and Licensure, in consultation with the Department for the Blind and Vision Impaired, to make recommendations regarding the certification of Braille instructors.

[H 2224]
Approved March 27, 2009

Be it enacted by the General Assembly of Virginia:

§ 1. That by December 31, 2009, the Advisory Board on Teacher Education and Licensure, in consultation with the Department for the Blind and Vision Impaired, shall make recommendations to the Board of Education and the Chairmen of the House Committee on Education and the Senate Committee on Education and Health regarding the certification of Braille instructors.

In consultation with the Department for the Blind and Vision Impaired, the Advisory Board on Teacher Education and Licensure (ABTEL) began discussions regarding Braille instruction, certification, and licensure. On March 16, 2009, the Advisory Board received a presentation from Mrs. Anne Wescott, assistant superintendent, Division of Policy and Communications, Virginia Department of Education, on the proposed legislation on Braille. On April 20, 2009, ABTEL received additional background information from Mrs. Patty Pitts, assistant superintendent for teacher education and licensure, Virginia Department of Education, and Mr. Glen Slonneger, education services program director, Department for the Blind and Vision Impaired. During the meeting on April 20, 2009, the Advisory Board approved a committee to research the policy issues and make recommendations to the full Advisory Board. Refer to Attachment A for the composition of the committee.

ABTEL's committee on Braille convened July 8 and August 5, 2009. At the meeting on August 5, 2009, Dr. Edward C. Bell, director of the Professional Development and Research Institute on Blindness, Louisiana Technology University, and Mr. Michael Kasey, National Federation of the Blind, met with the committee to present information on The National Literary Braille Competency Test. The Advisory Board on Teacher Education and Licensure met on September 20-21, 2009, to review the committee's report and make a recommendation to the Board of Education. The Advisory Board received the report of the

committee including research on Braille instruction, authority regarding Braille instruction, licensure assessments, the current teacher workforce with endorsements in visual impairments, Virginia's consortium to prepare teachers of visual impairments, requirements of other states, and available Braille assessments.

Research:

Articles:

The Braille Literacy Crisis in America: Facing the Truth, Reversing the Trend, Empowering the Blind [A Report to the Nation by the National Federation of the Blind Jernigan Institute]
http://www.nfb.org/images/nfb/documents/word/The_Braille_Literacy_Crisis_In_America.doc

Keeping Our Promises: Braille Competency Test Now a Reality, by Louis Walch
http://www.nfb.org/images/nfb/Publications/bm/bm08/bm0807/bm080710.htm

A Fresh Look at Braille by Jim Halliday, Closing the Gap, Inc.
http://www.kurzweiledu.com/files/Dec%20Jan%20Fresh%20Look.pdf

Fewer Blind Americans Learning Braille, MSNBC.com
http://www.msnbc.msn.com/id/29882719/

Documents:

What is Braille?, Virginia's Braille Awareness Guide, Produced by the Virginia Department for the Visually Handicapped and the Virginia Department of Education

Braille Instruction, compiled by Teresa Blythe, Mid-South Regional Resource Center, University of Kentucky [This document provides information regarding other states' use of competency tests for Braille.]

National Certification in Literary Braille (NCLB)

Braille Training or Workshops Held by the Virginia Department for the Visually Impaired

Authority Related to Braille Instruction and Preparation of Teachers

Federal Special Education Regulations: 34 CFR Parts 300 and 301 Assistance to States for the Education of Children with Disabilities and Preschool Grants for Children With Disabilities; Final Rule

§ 300.324 Development, review, and revision of IEP.
…(iii) In the case of a child who is blind or visually impaired, provide for instruction in Braille and the use of Braille unless the IEP Team determines, after an evaluation of the child's reading and writing skills, needs, and appropriate reading and writing media (including an evaluation of the child's future needs for instruction in Braille or the use of Braille), that instruction in Braille or the use of Braille is not appropriate for the child;…

Code of Virginia

§ 22.1-217. Visually impaired children.

A. Special education for visually impaired children provided by a school division shall be established, maintained and operated jointly by the school board and the Virginia Department for the Blind and Vision Impaired subject to the regulations of the Board of Education. Braille instruction shall be included in the student's Individualized Education Plan (IEP), whenever appropriate. When developing the IEP for students with visual impairment, the presumption shall be that proficiency in literacy is essential for such student to achieve satisfactory educational progress. However, use of Braille shall not be required if other special education services are more appropriate to the student's educational needs, and the provision of other appropriate services shall not preclude Braille instruction.

B. The Virginia Department for the Blind and Vision Impaired shall prepare and deliver a program of special education services in addition to the special education provided in the public school system designed to meet the educational needs of visually impaired children between the ages of birth and twenty-one and may prepare and deliver such programs for such individuals of other ages. In the development of such a program, the Virginia Department for the Blind and Vision Impaired shall cooperate with the Board of Education and the school boards of the several school divisions. The Virginia Department for the Blind and Vision Impaired shall assist the Board of Education and the school boards of the several school divisions with in-service training in Braille for currently employed teachers of students who are blind and visually impaired.

C. As used in this section:

"Braille" means the system of reading and writing through touch and is commonly known as standard English Braille Grade 2.

"Program" means a modified program which provides special materials or services and may include the employment of itinerant teachers or resource room teachers for the visually impaired.

"Visually impaired" shall be defined by the Board of Education and the Virginia Department for the Blind and Vision Impaired.

(Code 1950, § 22-10.7; 1974, c. 480; 1978, c. 386; 1980, c. 559; 1990, c. 803; 1992, c. 755; 1995, c. 750; 1998, c. 852.)

Virginia State Special Education Regulations

8VAC20-81-110. Individualized education program.

…2. The IEP team also shall: (34 CFR 300.324(a))

a. In the case of a child whose behavior impedes the child's learning or that of others, consider the use of positive behavioral interventions, strategies, and supports to address the behavior;

b. In the case of a child with limited English proficiency, consider the language needs of the child as those needs relate to the child's IEP;

c. In the case of a child who is blind or visually impaired, provide for instruction in Braille and the use of Braille unless the IEP team determines after an evaluation of the child's reading and writing skills, needs, and appropriate reading and writing media, including an evaluation of the child's future needs for instruction in Braille or the use of Braille, that instruction in Braille or the use of Braille is not appropriate for the child;

d. Consider the communication needs of the child;

e. Consider the child's needs for benchmarks or short-term objectives;

f. In the case of a child who is deaf or hard of hearing, consider the child's language and communication needs, opportunities for direct communications with peers and professional personnel in the child's language and communication mode, academic level, and full range of needs, including opportunities for direct instruction in the child's language and communication mode; and

g. Consider whether the child requires assistive technology devices and services…

Code of Virginia

§ 22.1-298.1. Regulations governing licensure.

B. The Board of Education shall prescribe, by regulation, the requirements for the licensure of teachers and other school personnel required to hold a license…

Licensure Regulations for School Personnel (effective September 21, 2007)

8VAC20-22-550. Special education visual impairments preK-12.

Endorsement requirements. The candidate must have:

1. Graduated from an approved teacher preparation program in special education visual impairments preK-12; or

2. Completed a major in special education visual impairments or 27 semester hours in education of students with visual impairments, including at least one course in foundations/legal aspects of special education; characteristics of persons with visual impairments; psycho-educational assessment and assessment for visual impairment; language/literacy skill development; Braille reading and writing; behavior management; transition; consultation; anatomy, physiology, and diseases of the eye; and instructional programming and methods.

Regulations Governing the Review and Approval of Education Programs in Virginia (effective September 21, 2007)

8VAC20-542-490. Special education visual impairments preK-12.

The program in special education visual impairments preK-12 is designed to ensure through course work and field experiences in a variety of settings that the candidate has demonstrated the following competencies:

1. Understanding of the characteristics of individuals with disabilities, including…

2. Understanding of the foundation of the legal aspects associated with students with disabilities and students with visual impairments, including:…

3. Understanding of the foundation of assessment and evaluation with an emphasis on individuals with visual impairments, including:...

4. Understanding of service delivery, classroom and behavior management, and instruction, including:…

5. Understanding of consultation, case management, and collaboration including:…

6. Understanding of the foundations of Braille reading and writing, including:

   a. Teaching reading and writing of grade 2 Braille on both a Braille writer and a "slate and stylus"; and

   b. Knowledge of other codes, including Nemeth, music code, and computer Braille.

7. Understanding of anatomy, physiology, and diseases of the eye and the educational implications.

8. Understanding of the standards of professionalism.

9. Completion of supervised classroom experiences at the elementary and secondary levels with students who have visual impairments.

Licensure Assessments

Currently, Virginia requires the following assessments for individuals seeking an initial license with an endorsement in Special Education-Visual Impairments. Virginia does not offer a separate endorsement in Braille.

Virginia Communication and Literacy Assessment (effective January 1, 2006)
The Virginia Communication and Literacy Assessment became effective January 1, 2006, for initial licensure unless an individual meets the exemption criteria. Refer to the following Web site for more information about the test content, test dates, costs, accommodations for individuals with disabilities, and registration: www.va.nesinc.com.

On March 22, 2006, the Board of Education approved cut scores for the Virginia Communication and Literacy Assessment (VCLA). The cut scores for the VCLA are as follows:

Writing Sub Test: 235
Reading Sub Test: 235
Composite Score: 470

Virginia Reading Assessment (VRA)
Individuals seeking initial licensure with endorsements in the following areas must take the Virginia Reading Assessment for Elementary and Special Education Teachers (Test Code 001) unless the exemption criteria are met:

Early/Primary prek-3
Elementary Education prek-6
Special Education-General Curriculum
Special Education-Hearing Impairments
Special Education-Visual Impairments

The VRA became a requirement July 1, 2004. Individuals who take the VRA after July 1, 2006, will be required to meet a passing score established by the Virginia Board of Education. The Board of Education established cut scores for the Virginia Reading Assessments for elementary and special education teachers at 235 and for reading specialists at 245, effective July 1, 2006. For information regarding registration, test administration, fees, etc., please visit the Web site, www.va.nesinc.com.

Teacher Work Force with the Endorsement in Special Education-Visual Impairments PreK-12

As of April 8, 2009, 325 individuals held an active Virginia license with the Special Education-Visual Impairments (VI) endorsement. There were 318 inactive Virginia licenses with the Visual Impairments endorsement. The chart below provides the number of teachers with the Visual Impairments endorsement by age bracket and license (active or inactive):

Teachers by Age Bracket with Visual Impairments Endorsement
As of April 8, 2009

Age Bracket	Active Licenses with the Visual Impairments Endorsement		Inactive Licenses with the Visual Impairments Endorsement	
Less than 30 years	18	5.5%	5	1.6%
30 to 34 years	14	4.3%	5	1.6%
35 to 39 years	18	5.5%	14	4.4%
40 to 44 years	40	12.3%	18	5.7%
45 to 49 years	44	13.5%	24	7.5%
50 to 54 years	56	17.2%	56	17.6%
55 to 59 years	90	27.7%	73	23.0%
60 to 64 years	35	10.8%	63	19.8%
65 years or more	10	3.1%	60	18.9%
Totals	**325**	**100%**	**318**	**100%**

Note that 191 (59 percent) of the teachers with an active Visual Impairments endorsement are age 50 or older.

In the most recent Instructional Personnel Report (2008-09 school year), school divisions reported 67 teachers as teaching in a position where only the Visual Impairments endorsement was acceptable for the assignment and who were endorsed in Visual Impairments. School divisions reported two teachers who were assigned in a teaching position where only the Visual Impairments endorsement was acceptable and who held licenses but did not hold the Visual Impairments endorsement.

School divisions reported 20 individuals who are endorsed in Visual Impairments and who are teaching in an assignment where the VI endorsement, as well as other special education endorsements, is acceptable.

Virginia Institutions of Higher Education Consortium: Visual Impairments Prek-12

George Mason University, James Madison University, Norfolk State University, Old Dominion University, and Radford University offer the required coursework for the endorsement in Special Education-Visual Impairments Prek-12. The requirements include six semester hours Braille instruction, including Braille I and Braille II.

Information from 20 preparation visual impairment programs in the United States (from the U.S. Personnel Center, the National Association of State Directors of Special Education (NASDSE) database, April 2009) showed the following number of semester hours of coursework required in Braille:

Number of Semester Hours of Braille	Number of Preparation Programs
3	7
4	1
5	3
6	6 (including Virginia's consortium)
7	1
8	1
9	1

Braille Assessment Requirements in Other States

The Mid-South Regional Resource Center conducted research in February 2009 to obtain national information on Braille assessment requirements in other states. The study reports, of the 23 states responding to the survey, Nebraska, Washington, Wisconsin, and West Virginia use the National Literacy Braille Competency Test. Arizona and Delaware require the National Library of Congress Braille Competency Test. Texas does require a Braille assessment administered by the Educational Testing Service.

Assessments in Braille

The Advisory Board committee reviewed assessment options in Braille. Tests used for licensure purposes must be valid, reliable**,** and legally defensible assessments available statewide. The committee investigated and found the following information relative to current Braille assessments.

National Certification in Literary Braille (NCLB)
The National Blindness Professional Certification Board (NBPCB) [http://www.nbpcb.org] was created to certify qualified specialists in work with the blind. At present, the Certification Board offers two certifications - the National Orientation and Mobility Certification (NOMC), and the National Certification in Literary Braille (NCLB). Refer to Attachment B for additional information regarding the NCLB.

National Evaluation Systems (Pearson)

National Evaluation Systems (Pearson) does not have a Braille-only test at this time. The company offers content area tests for the Visually Impaired endorsement for multiple states. These tests have a Braille component, but also assess other areas. Among the states included are New York, Illinois, Oklahoma, Michigan, Colorado, and Arizona.

Educational Testing Service (ETS)

The Educational Testing Service administers a Braille-only test for the state of Texas. Information on the assessment may be accessed at the following Web site: http://www.texes.ets.org/assets/pdf/testprep_manuals/182_183_visimpbraille_55101_web.pdf (Refer to page 49.) The state of Mississippi is also considering adopting this test for use in their state.

Advisory Board on Teacher Education and Licensure's Recommendation

The Advisory Board unanimously recommends to the Board of Education that a reliable, valid, and legally defensible assessment available statewide (to be determined) demonstrating Braille proficiency prescribed by the Virginia Board of Education be required for individuals seeking an initial license with an endorsement in Special Education-Visual Impairments. [The Department of Education shall follow policies and procedures relative to the procurement of such an assessment.] Additionally, contingent upon available funding, opportunities for licensed teachers with the endorsement in Visual Impairments be afforded additional professional development in the teaching of Braille through the Virginia Department of Education and the Department for the Blind and Vision Impaired. The Advisory Board supports the Virginia Board of Education's efforts to include teachers of visual impairments in the Standards of Quality funding formula.

ATTACHMENTS

Attachment A

Advisory Board on Teacher Education and Licensure Committee on Braille

ABTEL Members

Tracey Dingus, Chair of ABTEL
Carole Grove, Chair of the Teacher Education Committee
Angela Turley, Member
Dawn Rees-Blakeman, Member

Department for the Blind and Vision Impaired Representative

Glen Slonneger, Education Services Program Director

Department of Education Staff Resources

Division of Teacher Education and Licensure
Patty S. Pitts, Assistant Superintendent for Teacher Education and Licensure
JoAnne Y. Carver, Director of Teacher Education
James W. Lanham, III, Director of Licensure

Division of Special Education and Student Services
H. Douglas Cox, Assistant Superintendent for Special Education and Student Services
John Eisenberg, Director of Instructional Support and Related Services
Karen Trump, Special Education Coordinator

Division of Policy
Anne D. Wescott, Assistant Superintendent for Policy and Communications

Attachment B

National Certification in Literary Braille (NCLB)
Candidate Guidelines

SOURCE:
http://www.nbpcb.org/downloads/NCLBCertification/NCLB_Candidate_Guidelines.doc
Revised 03/2008

1.0 Overview
The National Blindness Professional Certification Board (NBPCB) has established rigorous standards for certifying competent professionals who wish to demonstrate their knowledge and proficiency in reading and writing the literary Braille code. Successful applicants who earn the designation, National Certification in Literary Braille (NCLB), associated with the National Literary Braille Competency Test (NLBCT) are entitled to all rights and responsibilities therein as long as he or she maintains active certification status and upholds the NBPCB Code of Professional Ethics.

The National Literary Braille Competency Test (NLBCT) is used to measure the level of a person's ability to read and write contracted literary Braille. Although the test can be taken by anyone, it is intended primarily for teachers of Braille and future teachers of Braille. The test has been revised and thoroughly pilot tested, and is now ready for public release.

1.1 History
The original Braille competency test was maintained and administered by the National Library Service for the Blind and Physically Handicapped (NLS) of the Library of Congress. It was developed in response to a recommendation of the Committee on Joint Organizational Effort (JOE), which was made up of representatives from the American Council of the Blind, the American Foundation for the Blind, the Association for Education and Rehabilitation of the Blind and Visually Impaired, the Blinded Veterans Association, the Canadian Council of the Blind, the Canadian National Institute for the Blind, the National Federation of the Blind, and The National Library Service for the Blind and Physically Handicapped (NLS) of the Library of Congress. The promotion of Braille literacy, and thus the development of the test, was born out of the committee's concern that teachers of blind children and adults should have sufficient knowledge and skills in Braille.

In 2005, the National Federation of the Blind (NFB) was asked to take over leading the development of the test. The NFB, along with a steering committee of experts in the field, including members of the National Blindness Professional Certification Board (NBPCB),

has reviewed, updated, and revised the test to meet today's needs in the field. The target population of individuals who will take the test is now seen as including pre and in-service teachers who teach or will teach Braille reading and writing to children and adults, and other individuals interested in demonstrating their knowledge/proficiency in reading and writing the Braille literary code as defined in the 1994 version of the *English Braille American Edition* (EBAE) Revised in 2002.

In March, 2007, it was decided that the National Blindness Professional Certification Board (NBPCB) should lead in the final stages of test development. The revised test is now in finished form, and is administered solely under the direction of the NBPCB.

Important note: The test materials were only slightly modified to reflect changes in purpose and target population. The test has not been substantially changed from its earlier version administered by the NLS. However, those who take the test now have the advantage of becoming candidates to receive the National Certification in Literary Braille (NCLB).

1.2 Structure of the Test

The NLBCT is a written examination that tests an applicant's ability to read, write, and understand literary Braille. The examination consists of four sections:

1. Braille writing using a Braille writer
2. Braille writing using a slate and stylus
3. Proofreading, identifying Braille errors
4. Multiple choice questions, correct usage and rules

(See Section 4.0 for more details.)

1.3 Important Terminology

CBMR: Consumer Based Model of Rehabilitation refers to the collective knowledge, experiences, and attitudes of the organized blind who have achieved economic, social, and community integration.

CBP: Certified Blindness Professional, as determined by the National Blindness Professional Certification Board (NBPCB).

JOE: Joint Organizational Effort. The committee that worked collaboratively in the development and testing of the NLBCT.

NBPCB: The National Blindness Professional Certification Board, which is the body responsible for all certification activities, policies, and decisions.

NCLB: National Certification in Literary Braille. The professional credential awarded to successful applicants who receive a passing score on all four sections of the NLBCT. This certification attests that the candidate has successfully demonstrated the capacity to effectively read, write, and understand literary Braille.

NLBCT: National Literary Braille Competency Test is used to measure the level of a person's ability to read and write contracted literary Braille. Although the test can be taken by anyone, it is intended primarily for teachers of Braille and future teachers of Braille.

NLS: National Library Service for the Blind and Physically Handicapped is the sector of the library of Congress which formerly administered the NLBCT.

EBAE: English Braille American Edition, the only reference allowed to be used during the NLBCT.

2.0 Preparation and Eligibility

There are no prerequisites for taking the National Literary Braille Competency Test. Interested individuals can make application to the NBPCB to sit for the test. It is presumed that applicants have received adequate preparation in learning to read and write literary—sometimes called contracted—Braille. This section contains the relevant information covered by the test and tips for test preparation. Please direct all further inquiries to the NBPCB office.

The test covers contracted literary Braille. The official reference of the test is the 1994 edition of EBAE Revised in 2002, available for purchase from APH. Not all of EBAE is covered in the test. The following are helpful preparations:

- Taking the sample test which is available to download from the NBPCB Web site http://www.nbpcb.org/pages/downloaddocuments.php
- Studying a literary Braille instruction manual
- Taking a college course in Braille
- Taking the Library of Congress course in Braille transcribing through lesson fifteen
- Reading recently published literary Braille
- Writing literary Braille using both a Braille writer and a slate and stylus

3.0 Application Process

All individuals wishing to demonstrate their proficiency in the literary Braille code may submit an application to the National Blindness Professional Certification Board. No application will be processed until the NBPCB has received the full application and fee. In addition, the applicant must submit a signed NBPCB Code of Professional Ethics Agreement form before the exam will be administered. This may be brought to the testing site with the applicant, faxed to (318) 257-2259, or mailed to NBPCB, NCLB Application, 101 S Trenton St, Ruston, LA 71270.

3.1 Application

Candidates may apply online at www.nbpcb.org/nclb/application or contact the NBPCB office at (318) 257-4554 for a paper application.

Allow up to three weeks for online applications, and up to six weeks for paper applications to be processed.

3.2 Registration

After your application has been processed, you will be contacted by the NBPCB to confirm your testing date, time, location, and any other relevant information related to taking the exam.

3.3 Test Locations and Dates

The test will be held at a minimum of two (2) locations annually. In addition, the test may be convened by arrangement when all of the following are present:

- An appropriate number of applicants will be present to take the exam
- At least two (2) NBPCB appointed test administrative staff are available
- An acceptable test site can be procured

For current information regarding testing locations and dates, check the Web page, www.nbpcb.org/announcements, or contact the NBPCB office.

3.4 Accommodations

Any candidate who has a disability that prevents them from taking the test under standard testing conditions, may request reasonable modifications. This is possible if the candidate submits proper documentation well ahead of time. All documentation and specific requests must be received by the NBPCB office at least 30 business days prior to the testing date.

Please be aware that the NBPCB makes its best effort to provide as many accessibility options as possible; however, the test is currently limited to print (18-pt) and Braille.

3.4.1 Pre-approved Accommodations

The use of the following items have been pre-approved for blind or visually impaired candidates, and do not require additional documentation:

- Hand-held magnifier
- Closed Circuit Television (CCTV)
- Felt-tip marker

3.5 Code of Professional Ethics
At the time of application, candidates are expected to be familiar with the NBPCB code of professional ethics. The candidate is expected to have read, understood, and be willing to abide by the Code of Professional Ethics. The applicant and a witness must sign the NBPCB Code of Professional Ethics Agreement form. Both the Code of Professional Ethics and Agreement form are available from the NBPCB office or Web page.

3.6 Fees
A $250.00 application fee must be submitted with the application before an examination date will be set. (See Section 8.0-8.3 for information on payment).

4.0 Examination Process
The test consists of four (4) sections. The instructions, test passages, and questions, will be provided to all candidates in print (18-pt.) and a combination of contracted and uncontracted Braille.

Up to six (6) hours is allowed to take the entire test. Two sections will be presented in the morning session and two sections will be presented in the afternoon session. There will be a 10-minute break between the two morning sections and a 10-minute break between the two afternoon sections. There will also be a one-hour lunch break.

The four sections of the test are outlined in the table below:

SECTION:	TIME:	DESCRIPTION:
1. Braille writer	Two (2) hours	Contains passages that candidates will Braille using a Braille writer.
2. Slate and Stylus	One (1) hour	Contains passages that candidates will Braille using a slate and stylus.
3. Proofreading	Two (2) hours	Contains Braille passages with embedded errors which candidates must identify.
4. Multiple Choice	One (1) hour	Contains approximately 40 multiple choice questions.

The only reference that candidates may use during the test is a copy of *English Braille, American Edition, 1994* (EBAE), which is provided by the Test Administrator in print or Braille. This reference may be used during the entire test. Please note that candidates must use the copy of EBAE provided and may not use their own personal copy during the test.

Different versions of the examination will be administered to ensure integrity and confidentiality during each testing cycle. However, each version will entail the following components:

- Candidates will have a maximum of six (6) hours to complete the examination.

- The examination instructions will be available in print and Braille
- The examination content will be available in print and a mixture of contracted and uncontracted Braille
- The examination will occur in a well-lighted and quiet location
- There will be a scheduled break between each test section
- All examinations will be directly proctored by NBPCB staff
- All examinations will be scored by a panel of qualified test scorers

4.1 Equipment Candidates Should and Should Not Bring to the Test Site
The following table lists what candidates should and should not bring to the test site:

CANDIDATES SHOULD BRING:	CANDIDATES SHOULD NOT BRING:
• A Braille writer capable of making 40-cell lines • A slate and stylus • A Braille eraser • Pens • Pencils (optional)	• Laptop computers • Electronic notetakers • Refreshable Braille displays • Cellphones • Notes or references

Note: Any notes, equipment, or paraphernalia not directly related to the test must be left outside the testing area. Any questions about acceptable equipment or accommodations, should be addressed to the NBPCB office in writing at least 30 business days prior to the test date. See also sections 3.4 and 3.4.1 for more details.

4.2 Stopping or Canceling the Exam
The examination can be stopped by the Test Administrator or the applicant for the following reasons:

- The time limit is exceeded
- The test administrator deems that successful completion is impossible or unlikely
- Testing facility conditions deteriorate to the point that it prevents normal performance or evaluation
- The applicant does not want to continue
- The Test Administrator feels that the applicant is overly stressed or overwhelmed to the point that it affects performance
- The test administrator has evidence or adequate suspicion that the applicant is cheating or otherwise manipulating the test
- There is a fault in necessary equipment used during the test.

If the test is stopped or canceled for any of the above reasons, the applicant may choose to reschedule the exam within six months of the initial test, or 18 months of the initial application date, whichever comes first. Retesting fees will be assessed accordingly (see

Section 8.1). If the test is stopped or canceled for any reason that is outside the control of the applicant, the exam may be rescheduled within the indicated time frame at no additional cost to the applicant.

4.3 Grading of Examinations
Test results are solely based on individual performance. The following is a list of areas covered throughout the test with their respective percentage weights:

- Basic knowledge including letters and numbers 1%
- Contractions 68%
- Common punctuation and composition 26%
- Formatting 5%

Important note: Candidates should be advised that grading is based on accuracy. Speed is not currently being tested except to the extent that the applicant completes the test within the given time frame.

4.3.1 Reporting of Examination Scores
All examination scores will be turned into the NBPCB office by the test administrator. The NBPCB office will then determine successful/unsuccessful test completion, and scores will be mailed to the candidate within 30 days of completing all sections of the examination. Candidates will receive scores for each of the four test sections, as well as an indication of overall performance. The NBPCB will also send score reports to up to three other institutions designated by the candidate.

Candidates who successfully pass all sections of the test are eligible to receive the National Certification in Literary Braille (NCLB), and will receive an NCLB identification number and an original copy of the NCLB certificate. If the applicant fails to pass any section of the examination, he/she will be mailed a letter detailing which sections were failed and guidelines for retesting.

5.0 Retesting Procedures
If an applicant does not pass the certification examination on the first attempt, he/she should retake the examination in part or in full. The following guidelines apply to applicants who must retest:

- If the candidate fails only one section, then that section may be retaken.
- Any single section of the test that is failed must be retaken within six months of the initial test, or 18 months from the application date, whichever comes first.
- If the candidate fails more than one section, then all sections of the test must be retaken.
- A fee will apply each time a test or test section is re-taken.

- If any section of the examination is failed three (3) times, the applicant cannot apply for certification again until additional NBPCB approved training is received.

The candidate will be notified of examination scores within sixty (60) days of taking the examination. If the candidate is notified that one or more sections of the test are failed, he or she must contact the NBPCB office to schedule a time to retake the examination. The NBPCB office will provide the applicant with a re-examination place and date after the appropriate fees are paid. Scores for the retesting will be mailed to the applicant within sixty (60) days after completion of the exam. All examination procedures will be the same as the original examination (see Section 4.0).

6.0 Code of Professional Ethics and Grievance Procedures

All Certified Blindness Professionals (CBPs), working at all professional levels, shall treat persons who are blind or partially blind with dignity and respect and will provide the best possible training and related vocational rehabilitation services which can be offered, based upon the most current techniques and training principles available at the time.

The National Blindness Professional Certification Board's (NBPCB) Code of Professional Ethics is a public statement of the values and principles used to promote and maintain high standards of behavior among those specialists in work with the blind who become Certified Blindness Professionals (including NCLB) through the NBPCB certification processes. The NBPCB is committed to furthering the ability of persons who are blind or partially blind to function competently, independently, and successfully not only in their own environments but also as fully integrated and participating citizens in the broader society. It is the ongoing objective of CBPs to act in an ethical manner.

6.1 Abiding by the Code

All individuals who earn the National Certification in Literary Braille (NCLB) are obliged to conduct themselves in a manner consistent with the NBPCB Code of Professional Ethics. As part of the NCLB application process, individuals must read, understand, and be willing to abide by the Code of Professional Ethics. An agreement form will be included with the application packet which must be signed by the individual seeking NCLB designation and witnessed by a second person. The code of professional ethics and agreement form are also available for download from the NBPCB Web page.

6.2 Grievance

Any allegation of a violation of the Code of Professional Ethics shall be submitted in writing to the President (or his/her designee) for action. Where there is incontrovertible evidence of a violation of the Code by a current certificant which is not supported by written allegation, the Board has the authority to proceed with prosecution of the issue as though a complaint had been filed.

Within ten (10) days of the receipt of a written allegation of violation of the Code of Professional Ethics, the President (or his/her designee) shall name a three-member panel to review the allegation and shall furnish each member with a written copy of the complaint. The three (3) reviewers may be members of the NBPCB Board of Directors or the NCLB committee. The President shall name one of the three appointees as chairperson of the review panel.

Within twenty (20) days of receipt of the written allegation, the Chairperson of the review panel shall report the findings and recommendations of the panel to the President (or his/her designee) in writing, and the President shall notify the respondent in writing of the findings and recommendations of the panel.

6.3 Disciplinary Procedures

Any intentional violation of any section of the Code of Professional Ethics shall be prima facia evidence of a CBP's affirmative decision to choose voluntarily to relinquish NBPCB certification and to forfeit all rights or privileges which inure to a person by reason of holding NCLB certification. Where the finding of the panel has been either to recommend suspension or revocation of certification, the respondent may request that the entire NBPCB Board review the decision of the panel (see Section 7.0). This request must be in writing and submitted to the President within ten (10) days of receipt by the respondent of the panel's adverse decision.

Where a CBP's certification has been revoked, the respondent may apply for re-certification after one full year has elapsed following the final revocation. It will be the responsibility of the respondent to demonstrate to the Board that a good faith effort has been made to correct the acts or practices giving rise to the revocation. A written request for re-instatement of certification must be submitted directly to the President, and the Board shall determine whether or not to reinstate certification. The respondent may not simply apply for certification through the usual certification application process.

7.0 Appealing Certification Decisions

Eligibility criteria for certification are established by the Board of Directors of the NBPCB, and the decisions of the board are binding. Unsuccessful candidates will receive a written denial of certification. A process of appeal upon written submission is available to any denied candidate who feels that the eligibility criteria have been inaccurately, inconsistently, or unfairly applied.

The process of appeal does NOT permit:

- Additional time to acquire education, employment experience or supervision required for certification.
- Additional time to submit the documentation required for certification.

7.1 The Appeal Process
There is one level of appeal in the event of denial of initial certification or recertification. This structure assures:

- A review of the relevant facts
- An independent evaluation of the materials presented
- Fair and consistent application of eligibility criteria

The appellant must send to the NBPCB Board a written request for appeal, by certified mail postmarked within thirty (30) days of official receipt of the letter of denial. The request for appeal must include in a single packet: a signed statement of the grounds for appeal and all relevant documentation in support thereof. Only documentation included with the first appeal request will be considered.

The decision will be made by majority vote of the NBPCB Board. All documentation will be reviewed and discussed by each member of the NBPCB Board before an appeal is voted on. The majority decision of the board is binding.

8.0 Fees and Payment
Following is a list of the applicable fees for certification and acceptable methods of payment. Applications will not be processed if the appropriate fee is not paid in full at the time the application is submitted.

8.1 Fees
Application Fee – $250.00
Retest Fee – $250.00
Single Section – $75.00 (each section)
Certificate Replacement Fee – $20.00

8.2 Payment Information
All fees can be paid online by credit card or PayPal account. Fees may alternatively be paid by personal check, bank draft, or money order. All payments should be made out to:

NBPCB
NCLB Application
101 South Trenton Street
Ruston, LA 71270

8.3 Non-Sufficient Funds (NSF) Policy
A fee of $25.00 will be charged for any returned check due to NSF. Fees must then be paid by bank draft or money order. No services will be provided by NBPCB until the application fee is paid in full.

8.4 Refund Policy
If for some reason the applicant does not wish to take the exam after submitting his or her application, $150 of the total application fee will be refunded upon the applicant's request. If a test date has already been scheduled, the $150 will only be refunded if applicants cancel 30 days prior to taking the examination. All other fees are non-refundable.

9.0 Recertification Program
The National Blindness Professional Certification Board (NBPCB) recognizes the need for blindness professionals to continue their education and training in order to remain current on innovations and policies in the field. Individuals who successfully achieve NCLB certification will retain valid certification status for five (5) years from the date printed on the original certificate. Once the initial certification has lapsed, the individual must reapply to the NBPCB for recertification in order to maintain active NCLB certification. The NBPCB Recertification Program is designed to ensure that certificants maintain their competence in reading and writing literary Braille. At the end of the five year period, an individual holding certification can only be recertified by successfully completing a new version of the NLBCT examination. More information will be available soon. You may also contact the NBPCB office or visit the Web page at http://www.nbpcb.org/nclb/recertification to see if this information has been updated.

10.0 Contact Information
Please direct all applications and inquiries to:

NBPCB Coordinator
101 S Trenton
Ruston, LA
Ph: (318) 257-4554
Fax: (318) 257-2295
Braille@nbpcb.org
www.nbpcb.org

Board of Education Agenda Item

Item: H. **Date:** October 22, 2009

Board of Education Agenda Item

Topic: Final Review of Proposed Revised Curriculum Framework for 2009 *Mathematics Standards of Learning*

Presenter: Mr. Michael Bolling, Mathematics Coordinator

Telephone Number: (804) 786-6418 **E-Mail Address:** Michael.Bolling@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____
- _X_ Action requested at this meeting __Action requested at future meeting:

Previous Review/Action:

____ No previous board review/action

_X_ Previous review/action
Date July 23, 2009
Action Board of Education accepted the Proposed Revised Curriculum Framework for 2009 *Mathematics Standards of Learning* for first review and public comment.

Background Information:
New academic content *Mathematics Standards of Learning* were developed in 1995 and revised in 2001. The *Standards of Quality* require the Board of Education to review the *Standards of Learning* on a regular schedule. On February 19, 2009, the Board approved the 2009 *Mathematics Standards of Learning*. The Department of Education then took the following steps to produce a draft of the proposed revised Curriculum Framework for the 2009 *Mathematics Standards of Learning* for the Board's first review:

- Selected a review committee that consisted of individuals solicited from school divisions as well as other stakeholder groups to participate in the process;
- Met with the review committee during May 2009;
- Developed a draft of the proposed revised Curriculum Framework for the 2009 *Mathematics Standards of Learning*.

On July 23, 2009, the Virginia Board of Education accepted for first review the proposed revised Curriculum Framework for the 2009 *Mathematics Standards of Learning.* A public comment period was held from July 24, 2009, to September 18, 2009. A summarized review of public comment is contained in Attachment A.

Summary of Revisions:
The proposed revised Curriculum Framework for the 2009 *Mathematics Standards of Learning* in Attachment B contains minimal changes made as a result of public comment. These changes are indicated by double underlines and strikethroughs. Revisions include:

- corrections of typographical and formatting errors;
- revisions of language for clarification and/or specification of content and vocabulary;
- additions of essential knowledge and skills or background information for instruction, assessment, and/or vertical articulation;
- consolidation of content or background information;
- organization of topics to align with the sequence of the standard; and
- changes in word choice and limiters for instructional and assessment purposes.

Superintendent's Recommendation:
The Superintendent of Public Instruction recommends that the Board of Education accept for final review the proposed revised Curriculum Framework for the 2009 *Mathematics Standards of Learning* and permit the Department of Education to make technical edits as needed.

Impact on Resources:
This responsibility can be absorbed by the agency's existing resources at this time.

Timetable for Further Review/Action:
Following the Board of Education's approval of the Curriculum Framework for the 2009 *Mathematics Standards of Learning*, the Virginia Department of Education will post the document on the Department's Curriculum Framework Web site.

Attachment A

Summary of Comments on the Proposed Revised Curriculum Framework for 2009 *Mathematics Standards of Learning*

Summary of Online Comments

A total of 85 online comments were received for K-12 courses during the online public comment period from July 24, 2009, through September 18, 2009.

The number of online comments received by grade band, grade level, and course is as follows:

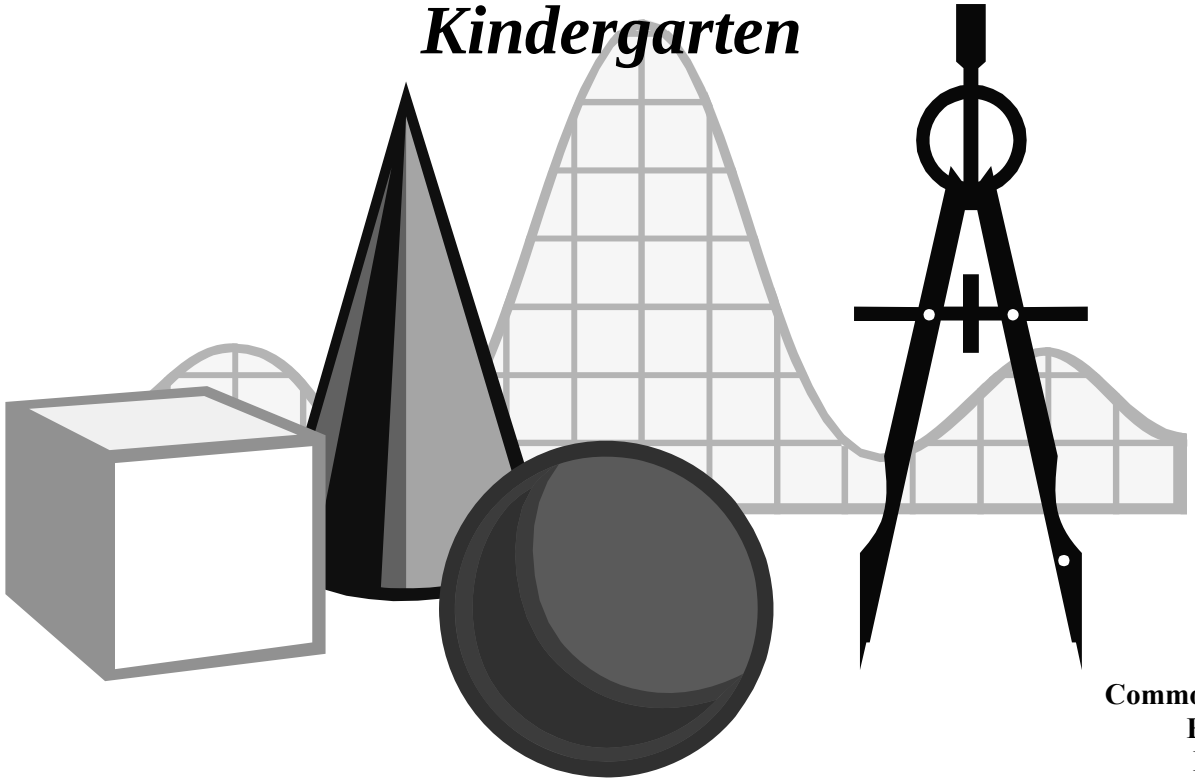
Grade Band, Grade Level, and Course	Number of Comments
K-12 General	48
1	7
2	6
3	5
4	0
5	6
6	4
7	1
8	1
Algebra I	1
Geometry	1
Algebra, Functions, and Data Analysis	0
Computer Mathematics	0
Algebra II	3
Trigonometry	1
Discrete Mathematics	0
Probability and Statistics	0
Mathematical Analysis	1
TOTAL	**85**

The majority of comments were positive regarding the revisions to the first draft of the Curriculum Framework. General, individual grade level, and course comments included suggestions for the following:

- alignment of essential knowledge and skills vertically among grade levels;
- clarification and/or specification of content;
- consideration of content for assessment purposes;
- consideration of the integration of fractal geometry;
- consideration of adding essential questions to the K-5 and end-of-course documents;
- consistency with vocabulary definitions and/or usage;
- correction of typographical errors;
- inclusion of additional essential knowledge and skills or background information;
- organization of topics to align with the sequence of the standards; and
- removal or consolidation of repeated content or background information.

PROPOSED REVISED MATHEMATICS STANDARDS OF LEARNING CURRICULUM FRAMEWORK

Kindergarten



Commonwealth of Virginia
Board of Education
Richmond, Virginia
Draft October 22, 2009

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NOTICE TO THE READER

The Virginia Department of Education does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities.

The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

Students in grades K–3 have a natural curiosity about their world, which leads them to develop a sense of number. Young children are motivated to count everything around them and begin to develop an understanding of the size of numbers (magnitude), multiple ways of thinking about and representing numbers, strategies and words to compare numbers, and an understanding of the effects of simple operations on numbers. Building on their own intuitive mathematical knowledge, they also display a natural need to organize things by sorting, comparing, ordering, and labeling objects in a variety of collections.

Consequently, the focus of instruction in the number and number sense strand is to promote an understanding of counting, classification, whole numbers, place value, ~~simple~~ fractions, number relationships ("more than," "less than," and "~~as many as~~ equal to"), and the effects of ~~simple~~ single-step and multistep computations ~~operations on numbers (fact families)~~. These learning experiences should allow students to engage actively in a variety of problem solving situations and to model numbers (compose and decompose), using a variety of manipulatives. Additionally, students at this level should have opportunities to observe, to develop an understanding of the relationship they see between numbers, and to develop the skills to communicate these relationships in precise, unambiguous terms.

K.1 The student, given two sets, each containing 10 or fewer concrete objects, will identify and describe one set as having more, fewer, or the same number of members as the other set, using the concept of one-to-one correspondence.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A set is a collection of distinct elements or items. • A one-to-one correspondence exists when two sets have an equal number of items. • Strategies for developing the concept of one-to-one matching involve set comparisons without counting. Hands-on experiences in matching items between two sets by moving, touching, and aligning objects, using one-to-one correspondence, enable visual as well as kinesthetic comparisons of the number of items in the two sets. • Students can also ~~use the strategy of~~ count~~ing~~ to make comparisons between two sets without matching the sets, using one-to-one correspondence. • Students are generally familiar with the concept of *more*, but have had little experience with the term *less*. It is important to use the terms together to build an understanding of their relationship. For example, when asking which group has more, follow with which group has less and vice versa.	**All students should** • Understand how quantities relate to each other, which leads to an understanding of how numbers are related to each other.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Match each member of one set with each member of another set, using the concept of one-to-one correspondence to compare the number of members between sets, where each set contains 10 or fewer objects. • Compare and describe two sets of 10 or fewer objects, using the terms *more, fewer,* and *the same*. • Given a set of objects, construct a second set which has more, fewer or the same number of objects.

K.2 The student, given a set containing 15 or fewer concrete objects, will
a) tell how many are in the set by counting the number of objects orally;
b) write the numeral to tell how many are in the set; and
c) select the corresponding numeral from a given set of numerals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Counting involves two separate skills: verbalizing the list of standard number words in order ("one, two, three, …") and connecting this sequence with the objects in the set being counted, using one-to-one correspondence. Association of number words with collections of objects is achieved by moving, touching, or pointing to objects as the number words are spoken. Objects may be presented in random order or arranged for easy counting. • Kinesthetic involvement (e.g., tracing the numbers, using tactile materials, such as sand, sandpaper, carpeting, or finger paint) facilitates the writing of numerals. • Articulating the characteristics of each numeral when writing numbers has been found to reduce the amount of time it takes to learn to write numerals. • Zero (0) is both a number and a digit. As a number, it plays a central role in mathematics as the additive identity of the integers, real numbers, and many other algebraic structures. As a digit, zero is used as a placeholder in systems. • *Conservation of number* and *cardinality principle* are two important milestones in development to attaching meaning to counting. • The cardinality principle refers to the concept that the last counted number describes the total amount of the counted set. It is an extension of one-to-one correspondence.	**All students should** • Read and write numerals from 0 through ~~10~~ 15. • Understand that the total number of objects can be found by counting. • Understand that the last counted number describes the total amount in the set. • Understand that if the set is empty, it has 0 elements. • Understand that changing the spatial arrangement of a set of objects does not change the total amount of the set.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Count orally the number of objects in a set containing ~~10~~ 15 or fewer concrete objects, using one-to-one correspondence, and identify the corresponding numeral. • Identify written numerals from 0 through ~~10~~ 15 represented in random order. • Select the numeral from a given set of numerals that corresponds to a set of ~~10~~ 15 or fewer concrete objects. • Write the numerals from 0 through ~~10~~ 15. • Write a numeral that corresponds to a set of ~~10~~ 15 or fewer concrete objects. • Construct a set of objects that corresponds to a given numeral, including an empty set.

K.2 The student, given a set containing 15 or fewer concrete objects, will
a) tell how many are in the set by counting the number of objects orally;
b) write the numeral to tell how many are in the set; and
c) select the corresponding numeral from a given set of numerals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Conservation of number is the understanding that the number of objects remains the same when they are rearranged spatially.		

K.3 The student, given an ordered set of ten objects and/or pictures, will indicate the ordinal position of each object, first through tenth, and the ordered position of each object.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Understanding the cardinal and ordinal meanings of numbers is necessary to quantify, measure, and identify the order of objects. • An ordinal number is a number that names the place or position of an object in a sequence or set (e.g., first, third). *Ordered position*, *ordinal position*, and *ordinality* are terms that refer to the place or position of an object in a sequence or set. • The ordinal position is determined by where one starts in an ordered set of objects or sequence of objects. • The ordinal meaning of numbers is developed by identifying and verbalizing the place or position of objects in a set or sequence (e.g., the student's position in line when students are lined up alphabetically by first name).	**All students should** • Use ordinal numbers to describe the ~~order~~ position of objects in a sequence.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the ordinal positions first~~, second, and third~~ through tenth using ordered sets of ~~three~~ ten concrete objects and/or pictures of such sets presented from – left-to-right; – right-to-left; – top-to-bottom; and/or – bottom-to-top.

K.4 The student will

a) count forward to 100 and backward from 10;
b) identify one more than a number and one less than a number; and
c) count by fives and tens to 100.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Counting skills are essential components of the development of number ideas; however, they are only one of the indicators of the understanding of numbers. • Counting forward by rote advances the child's development of sequencing. The natural numbers are 1, 2, 3, 4…. The whole numbers are 0, 1, 2, 3, 4…. Students should count the ~~natural~~ whole numbers 0, 1, 2, 3, 4,…. ~~These are not to be confused with the whole numbers that begin with the integer zero.~~ • Counting backward by rote lays the foundation for subtraction. Students should count backward beginning with 10, 9, 8,… through …3, 2, 1, 0. • Counting forward and backward leads to the development of counting on and counting back. • The patterns developed as a result of skip counting are precursors for recognizing numeric patterns, functional relationships, and concepts underlying money, time telling, and multiplication. Powerful models for developing these concepts include, but are not limited to, counters, hundred chart, and calculators. • Skip counting by fives lays the foundation for reading a clock effectively and telling time to the nearest five minutes, counting money, and developing the multiplication facts for five. • Skip counting by tens is a precursor for use of place value, addition, counting money, and	**All students should** • Use the correct oral counting sequence in both forward and backward counting situations. • Understand that skip counting can be used to count a collection of objects. • Describe patterns in skip counting and use those patterns to predict the next number or numbers in the skip counting sequence. • Understand that numeric relationships include one more than, one less than, two more than, two less than, etc. • Understand benchmarks of five and ten.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Count forward from ~~1~~ 0 to ~~30~~ 100. • Count backward from 10 to ~~1~~ 0. • Recognize the relationship of one more than and one less than a number using objects (i.e., five and one more is six; and one less than ten is nine). • Group ~~30~~ 100 or fewer objects together into sets of fives or tens and then count them by fives or by tens. • ~~Investigate and recognize the pattern of counting by fives and tens, using 30 or fewer concrete objects.~~ • Investigate and recognize the pattern of counting by fives ~~and tens~~ to ~~30~~ 100, using a ~~calculator~~ variety of tools. • Investigate and recognize the pattern of counting by ~~fives and~~ tens to ~~30~~ 100, using a ~~calculator~~ variety of tools.

K.4 The student will

a) count forward to 100 and backward from 10;
b) identify one more than a number and one less than a number; and
c) count by fives and tens to 100.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
multiplying by multiples of 10. • Calculators can be used to display the numeric patterns that result from skip counting. ~~Use the constant feature of the four-function calculator to display the numbers in the sequence when skip counting by that constant. For example, when skip counting by fives, press 5 + 5 = = =… to produce 5, 10, 15,….~~		

K.5 The student will identify the parts of a set and/or region that represent fractions for halves and fourths.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A fraction is a way of representing part of a whole (as in a region/area model) or part of a group (as in a set model). • In each fraction model, the parts must ~~be equal (i.e., each pie piece must~~ have the same area~~)~~. ~~In problems with fractions, a whole is broken into equal-size parts and reassembled into one whole.~~ • The fractional parts of a set model are subsets of an equal number. For example, in a set of ten cubes, each half would be a subset of five cubes. • Informal, integrated experiences with fractions at this level will help students develop a foundation for deeper learning at later grades. Understanding the language of fractions furthers this development (e.g., ~~*thirds*~~ *fourths* means "~~three~~ four equal parts of a whole" or $\frac{1}{4}$ represents one of ~~three~~ four ~~equal-size~~ parts of equal size when a pizza is shared among ~~three~~ four students).	**All students should** • Understand that fractional parts are equal shares of a whole region or a whole set. • Understand that the fraction name (*half*, *fourth*) tells the number of equal parts in the whole. • Understand that the fraction name (*half*, *fourth*) of the set model is a subset of the whole set with equal numbers.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize fractions as representing parts of equal size of a whole. • Given a region, identify half and/or a fourth of the region. • Given a set, identify half and/or a fourth of the set.

A variety of contexts are necessary for children to develop an understanding of the meanings of the operations such as addition and subtraction. These contexts often arise from real-life experiences in which they are simply joining sets, taking away or separating from a set, or comparing sets. These contexts might include conversations, such as "How many books do we have altogether?" or "How many cookies are left if I eat two?" or "I have three more candies than you do." Although young children first compute using objects and manipulatives, they gradually shift to performing computations mentally or using paper and pencil to record their thinking. Therefore, computation and estimation instruction in the early grades revolves around modeling ~~and~~, discussing, and recording a variety of problem situations. This approach ~~to~~ helps students ~~move~~ transition from the concrete to the representation to the symbolic ~~the abstract~~ ~~and~~ in order to develop meaning for the operations and how they relate to each other.

In grades K–3, computation and estimation instruction focuses on

- relating the mathematical language and symbolism of operations to problem situations;
- understanding different meanings of addition and subtraction of whole numbers and the relation between the two operations;
- developing proficiency with basic addition, subtraction, multiplication, division ~~facts~~ and related facts ~~families~~;
- gaining facility in manipulating whole numbers to add and subtract and in understanding the effects of the operations on whole numbers;
- developing and using strategies and algorithms to solve problems and choosing an appropriate method for the situation;
- choosing, from mental computation, estimation, paper and pencil, and calculators, an appropriate way to compute;
- recognizing whether numerical solutions are reasonable;
- experiencing situations that lead to multiplication and division, such as equal groupings of objects and sharing equally; and
- performing initial operations with fractions ~~and decimals~~.

K.6 The student will model adding and subtracting whole numbers, using up to 10 concrete objects.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Whole numbers are 0, 1, 2, 3, 4, 5, 6, and so on. • Addition is the process of combining or joining sets. • Subtraction can be viewed as a ~~"~~taking away~~"~~ or ~~"~~separating~~"~~ process or as compare to find the difference between two sets. • Counting on from the larger set to determine the sum of the combined sets is a strategy for finding a sum. • Counting backward from the larger set to determine the difference between two sets is a strategy for subtraction. • Number relationships, including the following, help students develop strategies for adding and subtracting. – Instant recognition of the amount in a set of objects that are arranged in a familiar pattern such as the dots on number cubes – One more than, one less than, two more than, two less than	**All students should** • Understand that addition j~~oins~~ means putting things ~~objects~~ together and that subtraction is the inverse of addition and means ~~separates~~ to separate ~~objects~~ things out.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Combine two sets with known quantities in each set, and count the combined set using up to 10 concrete objects, to determine the sum, where the sum is not greater than 10 ~~concrete objects~~. • Given a set of 10 or fewer concrete objects, ~~Remove~~ remove, ~~"~~take away,~~"~~ or separate part of ~~a~~ the set ~~from a given set to~~ and determine the result ~~of subtraction~~.

Measurement is important because it helps to quantify the world around us and is useful in so many aspects of everyday life. Students in grades K–3 should encounter measurement in many normal situations, from their daily use of the calendar and from science activities that often require students to measure objects or compare them directly, to situations in stories they are reading and to descriptions of how quickly they are growing.

Measurement instruction at the primary level focuses on developing the skills and tools needed to measure length, weight/mass, capacity, time, temperature, area, perimeter, volume, and money. Measurement at this level lends itself especially well to the use of concrete materials. Children can see the usefulness of measurement if classroom experiences focus on estimating and measuring real objects. They gain deep understanding of the concepts of measurement when handling the materials, making physical comparisons, and measuring with tools.

As students develop a sense of the attributes of measurement and the concept of a measurement unit, they also begin to recognize the differences between using nonstandard and standard units of measure. Learning should give them opportunities to apply both techniques and nonstandard and standard tools to find measurements and to develop an understanding of the use of simple U.S. Customary and metric units.

Teaching measurement offers the challenge to involve students actively and physically in learning and is an opportunity to tie together other aspects of the mathematical curriculum, such as fractions and geometry. It is also one of the major vehicles by which mathematics can make connections with other content areas, such as science, health, and physical education.

K.7 The student will recognize a penny, nickel, dime, and quarter and will determine the value of a collection of pennies and/or nickels whose total value is 10 cents or less.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Involvement in varied activities such as physically manipulating coins and making comparisons about their sizes, colors, and values is prerequisite to the skills of coin recognition and valuation. • Counting money helps students gain an awareness of consumer skills and the use of money in everyday life. • A variety of classroom experiences in which students manipulate physical models of money and count forward to determine the value of a collection of coins are important activities to ensure competence with using money. • ~~Establishing a one-to-one correspondence between the number names and the objects in a set of coins (pennies and/or nickels) is essential for an accurate count.~~ • Students need experiences to develop the concept that a nickel has a value of five cents even though it is one object.	**All students should** • Develop common referents for identifying pennies, nickels, dimes, and quarters. • Understand the value of a collection of coins whose value is 10 cents or less.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe the properties/characteristics (e.g., color, relative size) of a penny, nickel, dime, and quarter. • Identify a penny, nickel, dime, and quarter. • Identify that a nickel is the same value as five pennies. • Count a randomly placed collection of pennies and/or nickels (or models of pennies and/or nickels) whose value is 10 cents or less, and determine the value of the collection.

K.8 The student will identify the instruments used to measure length (ruler), weight (scale), time (clock: digital and analog; calendar: day, month, and season), and temperature (thermometer).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Many experiences in measuring physical objects, using nonstandard and standard units of measure, help to develop an intuitive understanding of measurement and will help students connect a tool with its purpose in measuring. • Selecting from among various measuring instruments and determining which can be used to solve various real-life problems are introduced at this level. • A precursor to connecting tools to a type of measurement is an introduction to the concepts of length, weight, time, and temperature.	**All students should** • Identify an appropriate measuring tool for a given unit of measure.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify a ruler as an instrument to measure length. • Identify different types of scales as instruments to measure weight. • Identify different types of clocks (analog and digital) as instruments to measure time. • Identify the components of a calendar, including days, months, and seasons. • Identify different types of thermometers as instruments used to measure temperature.

K.9 The student will tell time to the hour, using analog and digital clocks.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Many experiences in relating time on the hour to daily routines and school schedules (e.g., catching the bus, lunch time, recess time, and resource time) help students develop personal referents for time. • Making sense of telling time to the nearest hour is reinforced when students recognize the positions of the hands on an analog clock and identify the corresponding time to the hour.	**All students should** • Apply an appropriate technique, depending on the type of clock, to determine time to the nearest hour.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Tell time on an analog clock to the hour. • Tell time on a digital clock to the hour.

K.10 The student will compare two objects or events, using direct comparisons or nonstandard units of measure, according to one or more of the following attributes: length (shorter, longer), height (taller, shorter), weight (heavier, lighter), temperature (hotter, colder). Examples of nonstandard units include foot length, hand span, new pencil, paper clip, and block.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Length is the distance ~~along a line or figure from one point to another~~ between two points. • Height is the vertical length of a perpendicular to its base. • Weight is a measure of the heaviness of an object. • Temperature is the degree of hotness or coldness of an object (e.g., a body) or environment. • Students need to identify the attribute that they are measuring (e.g., length, height, weight, temperature) before they begin to measure. • ~~Extensive opportunities~~ Multiple hands-on experiences are needed to gain the ability to compare the attributes of objects.	**All students should** • Compare and order objects according to their attributes. • Develop an understanding of measuring with nonstandard and standard units of measure. • Recognize attributes (length, height, weight, temperature) that can be measured.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and describe lengths of two objects (as shorter or longer), using direct comparison or nonstandard units of measure (e.g., foot length, hand span, new pencil, paper clip, block). • Compare and describe heights of two objects (as taller or shorter), using direct comparison or nonstandard units of measure (e.g., book, hand span, new pencil, paper clip, block). • Compare and describe weights of two objects (as heavier or lighter), using direct comparison or nonstandard units of measure (e.g., book, cubes, new pencil, paper clip, block). • Compare and describe temperatures of two objects or environment (as hotter or colder), using direct comparison.

Children begin to develop geometric and spatial knowledge before beginning school, stimulated by the exploration of ~~shapes~~ figures and structures in their environment. Geometric ideas help children systematically represent and describe their world as they learn to represent ~~two- and three-dimensional~~ plane and solid ~~shapes~~ figures through drawing, block constructions, dramatization, and verbal language.

The focus of instruction at this level is on

- observing, identifying, describing, comparing, contrasting and investigating ~~three-dimensional~~ solid objects and their ~~two-dimensional~~ faces;
- sorting objects and ordering them directly by comparing them one to the other;
- describing, comparing, contrasting, sorting, and classifying ~~shapes~~ figures; and
- exploring symmetry, congruence, and transformation.

In the primary grades, children begin to develop basic vocabulary related to ~~these shapes~~ figures but do not develop precise meanings for many of the terms they use until they are thinking beyond Level 2 of the van Hiele theory (see below).

The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.

K.11 The student will

a) identify, describe, and trace plane geometric figures (circle, triangle, square, and rectangle); and

b) compare the size (larger, smaller) and shape of plane geometric figures (circle, triangle, square, and rectangle).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• An important part of the geometry strand in grades K through 2 is the naming and describing of ~~shapes~~ figures. Children move from their own vocabulary and begin to incorporate conventional terminology as the teacher uses geometric terms. • A plane geometric figure is any ~~two-dimensional~~ plane, closed ~~shape~~ figure. Circles and polygons are examples of plane geometric figures. • Presentation of triangles, rectangles, and squares should be made in a variety of spatial orientations so that students do not develop the common misconception that triangles, rectangles, and squares must have one side parallel to the bottom of the page on which they are printed. • The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding. – **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons. – **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same (e.g., "I know it's a rectangle because it looks like a door, and I know	**All students should** • Use their knowledge of ~~two-dimensional~~ plane figures to help them systematically represent and describe their world. • ~~Develop an understanding of the shapes of geometric figures by using various methods.~~ • Identify the characteristics of plane geometric figures (circle, triangle, square, and rectangle). • Compare the size and shape of plane geometric figures by using strategies to sort and/or group and begin to refine the vocabulary used to explain their strategies.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify a circle, triangle, square, and rectangle. • Describe the ~~properties~~ characteristics of triangles, squares, and rectangles, including number of sides and number of ~~corners~~ angles. • Describe a circle using terms such as round and curved. • ~~Draw~~ Trace a circle, triangle, square, and rectangle. • Compare and group plane geometric figures (circle, triangle, square, and rectangle) according to their relative sizes (larger, smaller). • Compare and group plane geometric figures (circle, triangle, square, and rectangle) according to their shapes. • Distinguish between examples and nonexamples of identified geometric figures (circle, triangle, square, and rectangle).

K.11 The student will

a) identify, describe, and trace plane geometric figures (circle, triangle, square, and rectangle); and

b) compare the size (larger, smaller) and shape of plane geometric figures (circle, triangle, square, and rectangle).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
that a door is a rectangle.") – **Level 2: Analysis.** Properties are perceived, but are isolated and unrelated. Students should recognize and name properties of geometric figures (e.g., "I know it's a rectangle because it is closed; it has four sides and four right angles."). • A polygon is a geometric figure that – has sides that are ~~straight~~ line segments; – is simple (its sides do not cross); – is closed; and – is two-dimensional (~~it~~ lies in a plane). • A triangle is a polygon with three angles and three sides. Children should be shown different types of triangles such as equilateral, isosceles, scalene, right, acute, and obtuse; however, they are not expected to name the various types. • A quadrilateral is a polygon with four sides. • A rectangle is a quadrilateral with four right angles. • A square is a rectangle with all four sides of equal length. • A circle is a closed curve with all points in one plane and the same distance from a fixed point (the center). • Early experiences with comparing and sorting ~~shapes~~ figures assist students in analyzing the characteristics ~~and properties of two-dimensional geometric shapes~~ of plane geometric figures. • Attribute blocks, relational attribute blocks, ~~power blocks~~, and tangrams are among the		

K.11 The student will

a) identify, describe, and trace plane geometric figures (circle, triangle, square, and rectangle); and

b) compare the size (larger, smaller) and shape of plane geometric figures (circle, triangle, square, and rectangle).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
manipulatives that are particularly appropriate for sorting and comparing size. – Clay, straws, and paper and scissors are several manipulatives that are appropriate for constructing geometric figures.		

K.12 The student will describe the location of one object relative to another (above, below, next to) and identify representations of plane geometric figures (circle, triangle, square, and rectangle) regardless of their positions and orientations in space.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Representations of circles, squares, rectangles, and triangles can be found in the students' environment at school and at home. Students should have opportunities to identify/classify things in their environment by the type of ~~shape~~ figures those things represent. • Children are often confused when a ~~shape~~ figure such as a square is rotated: they frequently refer to the rotated square as a diamond. Clarification needs to be ongoing — i.e., a square is a square regardless of its location in space; there is no such geometric ~~shape~~ figure as a diamond. ~~• Geometric manipulatives that can be used to combine plane geometric figures to create familiar shapes are~~ ~~– tangrams;~~ ~~– attribute blocks;~~ ~~– pattern blocks;~~ ~~– power blocks;~~ ~~– relational attribute blocks; and~~ ~~– transformations (slides, flips, turns) on shapes, which can be applied to change the orientation of the shape.~~	**All students should** • ~~Use a variety of skills that relate to direction, distance, and position in space in order to enhance their navigation skills.~~ • Understand that objects can have different orientations in space.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify pictorial representations of a circle, triangle, square, and rectangle, regardless of their position and orientation in space. • Describe the location of one object relative to another, using the terms *above*, *below*, and *next to*.

Students in the primary grades have a natural curiosity about their world, which leads to questions about how things fit together or connect. They display their natural need to organize things by sorting and counting objects in a collection according to similarities and differences with respect to given criteria.

The focus of probability instruction at this level is to help students begin to develop an understanding of the concept of chance. They experiment with spinners, two-colored counters, dice, tiles, coins, and other manipulatives to explore the possible outcomes of situations and predict results. They begin to describe the likelihood of events, using the terms *impossible, unlikely, equally likely, more likely,* and *certain.*

The focus of statistics instruction at this level is to help students develop methods of collecting, organizing, describing, displaying, and interpreting data to answer questions they have posed about themselves and their world.

K.13 The student will gather data by counting and tallying.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data are pieces of information collected about people or things. The primary purpose of collecting data is to answer questions. • Tallying is a method for gathering information. Tally marks are used to show how often something happens or occurs. Each tally mark represents one occurrence. Tally marks are clustered into groups of five, with four vertical marks representing the first four occurrences and the fifth mark crossing the first four on a diagonal to represent the fifth occurrence. • When data are presented in an organized manner, students can describe the results of their investigation (i.e., identifying parts of the data that have special characteristics, including categories with the greatest, the least, or the same number of responses). • In the process of gathering data, students make decisions about what is relevant to their investigation (e.g., when collecting data on their classmates' favorite pets, deciding to limit the categories to common pets). • When students begin to collect data, they recognize the need to categorize, which helps develop the understanding of "things that go together." Categorical data are used when constructing ~~pictorial~~ picture graphs and bar graphs.	**All students should** • Pose questions and gather data. • Understand how data are collected and presented in an organized manner by counting and tallying.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Gather~~ Use counting and tallying to gather data on ~~given~~ categories identified by ~~counting and tallying~~ the teacher and/or student (e.g., favorites, number of days of various types of weather during a given month, types of pets, types of shoes).

K.14 The student will display gathered data in object graphs, picture graphs, and tables, and will answer questions related to the data.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Object graphs are graphs that use concrete materials to represent the categorical data that are collected (e.g., cubes stacked by the month, with one cube representing the birthday month of each student). • ~~Pictorial~~ Picture graphs are graphs that use pictures to show and compare information. ~~A key is often used to indicate what each picture represents (e.g., one picture of a dog represents five dogs).~~ • Tables are an orderly arrangement of data in which the data are arranged in columns and rows in an essentially rectangular format. Tables may be used to display some type of numerical relationship or organized lists (e.g., input/output functions, tables showing one candy costs five cents and two candies cost 10 cents). • Students represent data to convey results of their investigations at a glance, using concrete objects, pictures, and numbers to give a "picture" of the organized data. • When data are displayed in an organized manner, children can describe the results of their investigations. • Graphs can be used to make connections between mathematics and social studies and/or science (e.g., job areas and the different people that work in these areas: health — doctors and nurses; education — teachers and principals). • Statements representing an analysis and interpretation of the characteristics of the data in	**All students should** • Understand that data can be represented using concrete objects, pictures, and graphs. • Understand that different types of representations emphasize different things about the same data. • Understand that picture graphs use pictures to show and compare information; object graphs use concrete materials to represent categorical data; and tables can be used to show an orderly arrangement of data in columns and rows. • Answer questions related to the gathered data from object graphs, picture graphs, and tables. • Relate their ideas about the data to concepts such as part-part-whole and number relationships.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Display data by arranging concrete objects into organized groups to form a simple object graph. • Display gathered data, using ~~pictorial representations of the data~~ pictures to form a simple ~~pictorial~~ picture graph (e.g., a picture graph of the types of shoes worn by students on a given day). • Display ~~information~~ gathered data in tables, either in rows or columns ~~(e.g., a table showing the number of bunnies in one column and the number of ears the bunnies have in another or a table showing the time schedule for classroom activities)~~. • Answer questions related to the gathered data displayed in object graphs, picture graphs, and tables by: – Describing the categories of data and the data as a whole (e.g., the total number of responses) and its parts. – Identifying parts of the data that represent numerical relationships, including categories with the greatest, the least, or the same.

K.14 The student will display gathered data in object graphs, picture graphs, and tables, and will answer questions related to the data.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
the graph (e.g., similarities and differences, least and greatest, the categories, and total number of responses) should be asked.		

Stimulated by the exploration of their environment, children begin to develop concepts related to patterns, functions, and algebra before beginning school. Recognition of patterns and comparisons are important components of children's mathematical development.

Students in kindergarten through third grade develop the foundation for understanding various types of patterns and functional relationships through the following experiences:

- sorting, comparing, and classifying objects in a collection according to a variety of attributes and properties;
- identifying, analyzing, and extending patterns;
- creating repetitive patterns and communicating about these patterns in their own language;
- analyzing simple patterns and making predictions about them;
- recognizing the same pattern in different representations;
- describing how both repeating and growing patterns are generated; and
- repeating predictable sequences in rhymes and extending simple rhythmic patterns.

The focus of instruction at the primary level is to observe, recognize, create, extend, and describe a variety of patterns ~~in the real world~~. These students will experience and recognize visual, kinesthetic, and auditory patterns and develop the language to describe them orally and in writing as a foundation to using symbols. They will use patterns to explore mathematical and geometric relationships and to solve problems, and their observations and discussions of how things change will eventually lead to the notion of functions and ultimately to ~~A~~algebra.

K.15 The student will sort and classify objects according to attributes.

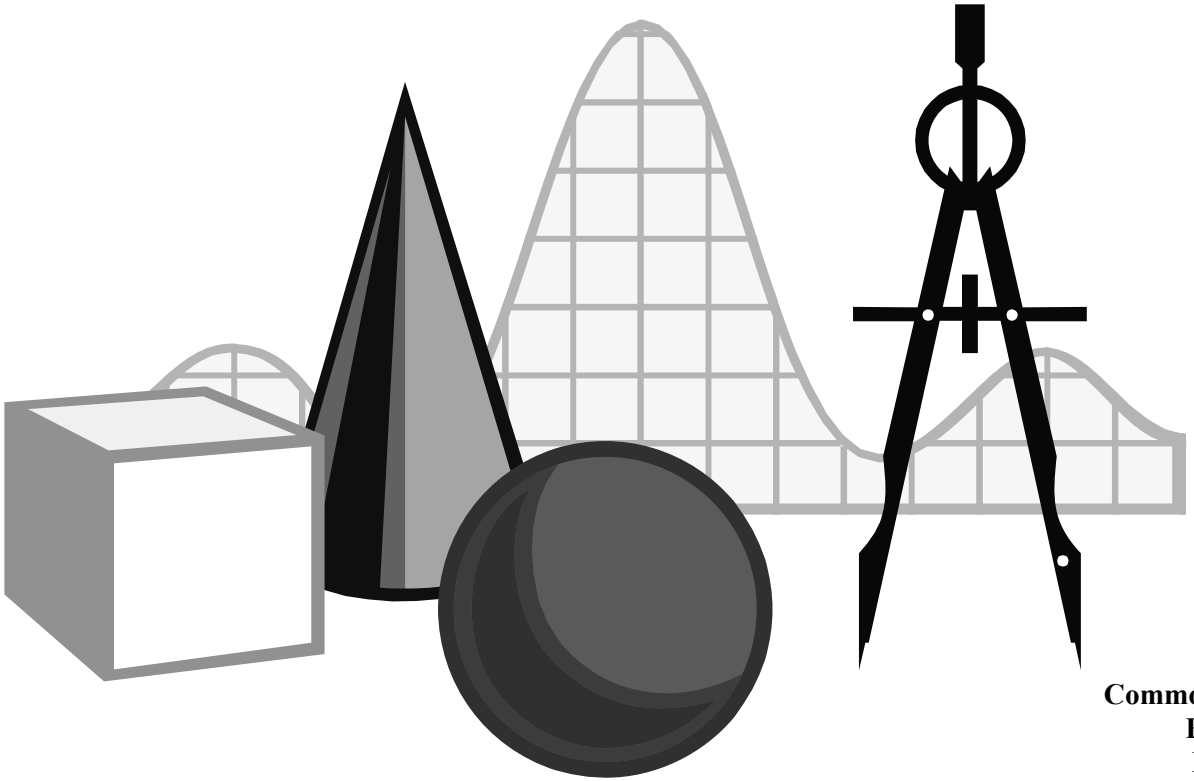
UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• To classify is to arrange or organize a set of materials according to a category or attribute (a quality or characteristic ~~of a thing~~). An object has many attributes such as color, size. shape, thickness, etc. • General similarities and differences among objects are easily observed by children entering kindergarten, who are able to focus on any one attribute. The teacher's task is to move students toward a more sophisticated understanding of classification in which two or more attributes connect or differentiate sets, such as those found in nature (e.g., leaves with different colors and different ~~shapes~~ figures).	**All students should** • Understand that the same set of objects can be sorted and classified in different ways.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Sort objects into appropriate groups (categories) based on one attribute~~, such as size, shape, or color~~. • Classify sets of objects into ~~three~~ groups (categories) of one attribute ~~(e.g., for size — small, medium, and large)~~. • Label attributes of a set of objects that has been sorted. • Name multiple ways to sort a set of objects.

K.16 The student will identify, describe, and extend repeating patterns.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Pattern recognition is a fundamental cornerstone of mathematics, particularly algebra. • In a repeating pattern, the core of the pattern is the string of elements that repeats. By identifying the core, students demonstrate their understanding of the pattern. • Students should recognize that the sound pattern 'snap, clap, snap, clap' is the same in form as the color pattern 'red, blue, red, blue'. • Pattern recognition and the extension of the pattern allows students to make predictions. • The simplest types of patterns are repeating patterns. The patterns can be oral, such as the refrain in "Old MacDonald's Farm" ("e-i-e-i-o"), or physical with clapping and snapping patterns, or combinations of both, such as is found in songs like the "Hokey Pokey." In each case, students need to identify the basic unit of the pattern and repeat it. Opportunities to create, recognize, describe, and extend repeating patterns are essential to the primary school experience. • Sample repeating patterns (repeating the ~~basic~~ core ~~unit)~~ are – ABABABAB; – ABCABC; – AABBAABBAABB; – AABAAB; – AABCAABC; and – ABACABAC.	**All students should** • Understand that patterns are a way to recognize order and organize their world and to predict what comes next in an arrangement. • Understand that the sound pattern 'snap, clap, snap, clap' is the same in form as the color pattern 'red, blue, red, blue'.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Observe and identify the basic repeating pattern (core) found in repeating patterns of common objects, sounds, and movements that occur in ~~real-life~~ practical situations~~, where there are four or fewer elements in the basic repeating pattern~~. • ~~Describe~~ Identify the ~~basic repeating pattern~~ core ~~found~~ in a repeating pattern~~, where there are four or fewer elements in the basic repeating pattern~~. • Extend a repeating pattern by adding at least two repetitions to the pattern. • Create a repeating pattern. • Compare similarities and differences between patterns.

MATHEMATICS STANDARDS OF LEARNING CURRICULUM FRAMEWORK

Grade 1



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The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

Students in grades K–3 have a natural curiosity about their world, which leads them to develop a sense of number. Young children are motivated to count everything around them and begin to develop an understanding of the size of numbers (magnitude), multiple ways of thinking about and representing numbers, strategies and words to compare numbers, and an understanding of the effects of simple operations on numbers. Building on their own intuitive mathematical knowledge, they also display a natural need to organize things by sorting, comparing, ordering, and labeling objects in a variety of collections.

Consequently, the focus of instruction in the number and number sense strand is to promote an understanding of counting, classification, whole numbers, place value, ~~simple~~ fractions, number relationships ("more than," "less than," and "~~as many as~~ equal to"), and the effects of ~~simple~~ single-step and multistep computations ~~operations on numbers (fact families)~~. These learning experiences should allow students to engage actively in a variety of problem solving situations and to model numbers (compose and decompose), using a variety of manipulatives. Additionally, students at this level should have opportunities to observe, to develop an understanding of the relationship they see between numbers, and to develop the skills to communicate these relationships in precise, unambiguous terms.

1.1 The student will

a) count from 0 to 100 and write the corresponding numerals; and

b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• There are three developmental levels of counting: – rote sequence; – one-to-one correspondence; and – the cardinality of numbers. • Counting involves two separate skills: verbalizing the list of standard number words in order ("one, two, three, …") and connecting this sequence with the items in the set being counted, using one-to-one correspondence. Association of number words with collections of objects is achieved by moving, touching, or pointing to objects as the number words are spoken. • The last number stated represents the number of objects in the set. This is known as the cardinality of the set. • Rote counting is a prerequisite skill for the understanding of addition, subtraction, and the ten-to-one concept of place value. • Articulating the characteristics of each numeral when writing numbers has been found to reduce the amount of time it takes to learn to write numerals. • The number system is based on a pattern of tens where each place has ten times the value of the place to its right. This is known as the ten-to-one concept of place value. • Opportunities to experience the relationships among tens and ones through hands-on experiences with manipulatives are essential to developing the ten-to-one place value concept of	**All students should** • Associate oral number names with the correct numeral and set of objects. • Understand that 1 and 10 are special units of numbers (e.g., 10 is 10 ones, but it is also 1 ten). • Understand the ten-to-one relationship of ones and tens (10 ones equals 1 ten). • Understand that numbers are written to show how many tens and how many ones are in the number. • Understand that groups of tens and ones can be used to tell how many.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Count by rote from ~~1~~ 0 to 100, using the correct name for each numeral. • Use the correct oral counting sequence to tell how many objects are in a set. • Write numerals correctly. • Write each numerals ~~for the numbers 1 to 100~~ from 0 to 100. • Read two-digit numbers when shown a numeral, a Base-10 model of the number, or a pictorial representation of the number. • Identify the place value (ones, tens) of each digit in a two-digit numeral (e.g., The place value of the 2 in the number 23 is tens. The value of the 2 in the number 23 is 20). • Group a collection of objects into sets of tens and ones. Write the numeral that corresponds to the total number of objects in a given collection of objects that have been grouped into sets of tens and ones.

1.1 The student will

a) count from 0 to 100 and write the corresponding numerals; and

b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
our number system and to understanding the value of each digit in a two-digit number. Ten-to-one trading activities with manipulatives on place value mats provide excellent experiences for developing the understanding of the places in the ~~b~~Base-10 system. • Models that clearly illustrate the relationships among tens and ones are physically proportional (e.g., the tens piece is ten times larger than the ones piece). • Providing students with opportunities to model two-digit numbers expressed with groups of ones and tens will help students understand the ideas of trading, regrouping, and equality. • Recording the numeral when using physical and pictorial models leads to an understanding that the position of each digit in a numeral determines the size of the group it represents.		

1.2 The student will count forward by ones, twos, fives, and tens to 100 and backward by ones from 30.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The patterns developed as a result of skip counting are precursors for recognizing numeric patterns, functional relationships, and concepts underlying money, time telling, and multiplication. Powerful models for developing these concepts include counters, number line, hundred chart, and calculators. • Skip counting by twos supports the development of the concept of even numbers. • Skip counting by fives lays the foundation for reading a clock effectively and telling time to the nearest five minutes, counting money, and developing the multiplication facts for five. • Skip counting by tens is a precursor for use of place value, addition, counting money, and multiplying by multiples of 10. • Counting backward by rote lays the foundation for subtraction. Students should count backward beginning with ~~20, 19, 18~~, 30, 29, 28, … through …3, 2, 1, 0. • Calculators can be used to reinforce skip counting. ~~Use the constant feature of the four-function calculator to display the numbers in the sequence when skip counting by that constant. For example, when skip counting by twos, press 2 + 2 = = =… to produce 2, 4, 6, 8, 10,…; or when skip counting by fives, press 5 + 5 = = =… to produce 5, 10, 15,….~~	**All students should** • Understand that collections of objects can be grouped and skip counting can be used to count the collection. • Describe patterns in counting by ones (both forward and backward) and skip counting and use those patterns to predict the next number in the counting sequence.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Count by ones, twos, fives, and tens to 100, using concrete objects, such as counters, connecting cubes, pennies, nickels, and dimes. • Demonstrate a one-to-one correspondence when counting by ones with concrete objects or representations. • Skip count orally by twos, fives and tens to 100 starting at various multiples of 2, 5, or 10. • Count backward by ones from ~~20~~ 30.

1.3 The student will identify the parts of a set and/or region that represent fractions for halves, thirds, and fourths and write the fractions.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A fraction is a way of representing part of a whole set or a whole region. • In a set fraction model, students need opportunities to make fair shares. For example, when sharing a set of 12 markers with three friends, each person would have one-third of the whole set. Also, each element of the set, no matter its size, is considered to be an equal share of the whole. • In an region/area fraction model, ~~In each fraction model, the parts must be equal (i.e., each pie piece must have the same area). In problems with fractions,~~ a whole is broken into equal-size parts and reassembled into one whole. • The words *denominator* and *numerator* are not required at this grade, but the concepts of part and whole are required for understanding of a fraction. • At this level, students ~~should not be~~ are expected to first understand the part-whole relationship (e.g., three out of four equal parts) before being expected to recognize or use symbolic representations for fractions (e.g., $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{4}$)~~,~~ ~~until they understand the part-whole relationship~~. • Students should have opportunities to make connections and comparisons among fraction representations by connecting concrete or pictorial representations with spoken representations (e.g., "one-half," "one out of two equal parts", or "two-thirds", "two out of three equal parts" and "one half is more than one	**All students should** • Understand that a fraction represents a part of a whole. • Understand that fractional parts are equal shares of a whole. • Understand that the fraction name (*half*, *third*, *fourth*) tells the number of equal parts in the whole.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Represent a whole to show it having two equal parts and identify one-half ($\frac{1}{2}$), and two halves ($\frac{2}{2}$). • Represent a whole to show it having three equal parts and identify one-third ($\frac{1}{3}$), two-thirds ($\frac{2}{3}$) and three-thirds ($\frac{3}{3}$). • Represent a whole to show it having four equal parts and identify one-fourth ($\frac{1}{4}$), two-fourths ($\frac{2}{4}$), three-fourths ($\frac{3}{4}$) and four-fourths ($\frac{4}{4}$). • Identify and model ~~one-half and one-fourth~~ halves, thirds, and fourths of a whole, using the set model (e.g., connecting cubes and counters), and region/area models (e.g., pie pieces, pattern blocks, geoboards, paper folding, and drawings)~~; and measurement models (e.g., cuisenaire rods, connecting cubes, fraction strips, drawings)~~. • Name and write fractions represented by drawings or concrete materials for halves, thirds, and fourths. • Represent a given fraction using concrete materials, pictures, and symbols for halves, thirds, and fourths. For example, write the symbol for one-fourth, and represent it with concrete materials and pictures.

1.3 The student will identify the parts of a set and/or region that represent fractions for halves, thirds, and fourths and write the fractions.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
fourth of the same whole" ~~but not $\frac{1}{2}$~~). • Informal, integrated experiences with fractions at this level will help students develop a foundation for deeper learning at later grades. Understanding the language of fractions (e.g., *thirds* means "three equal parts of a whole" ~~or $\frac{1}{3}$ represents one of three equal-size parts when a pizza is shared among three students~~) furthers this development.		

A variety of contexts are necessary for children to develop an understanding of the meanings of the operations such as addition and subtraction. These contexts often arise from ~~real-life~~ practical experiences in which they are simply joining sets, taking away or separating from a set, or comparing sets. These contexts might include conversations, such as "How many books do we have altogether?" or "How many cookies are left if I eat two?" or "I have three more candies than you do." Although young children first compute using objects and manipulatives, they gradually shift to performing computations mentally or using paper and pencil to record their thinking. Therefore, computation and estimation instruction in the early grades revolves around modeling ~~and~~, discussing, and recording a variety of problem situations. This approach ~~to~~ helps students ~~move~~ transition from the concrete to the representation to the symbolic ~~the abstract~~ ~~and~~ in order to develop meaning for the operations and how they relate to each other.

In grades K–3, computation and estimation instruction focuses on

- relating the mathematical language and symbolism of operations to problem situations;
- understanding different meanings of addition and subtraction of whole numbers and the relation between the two operations;
- developing proficiency with basic addition, subtraction, multiplication, division ~~facts~~ and related facts ~~families~~;
- gaining facility in manipulating whole numbers to add and subtract and in understanding the effects of the operations on whole numbers;
- developing and using strategies and algorithms to solve problems and choosing an appropriate method for the situation;
- choosing, from mental computation, estimation, paper and pencil, and calculators, an appropriate way to compute;
- recognizing whether numerical solutions are reasonable;
- experiencing situations that lead to multiplication and division, such as equal groupings of objects and sharing equally; and
- performing initial operations with fractions ~~and decimals~~.

1.4 The student, given a familiar problem situation involving magnitude, will

a) select a reasonable order of magnitude from three given quantities: a one-digit numeral, a two-digit numeral, and a three-digit numeral (e.g., 5, 50, 500); and

b) explain the reasonableness of the choice.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Magnitude refers to the size of a set. • Exploring ways to estimate the number of objects in a set, based on appearance, (e.g., clustering, grouping, comparing) enhances the development of number sense. • To estimate means to find a number that is close to the exact amount. When asking for an estimate, teachers might ask, "*about* how much?" or "*about* how many?" or "Is this about 10 or about 50?" • Students should be provided opportunities to estimate a quantity, given a benchmark of 10 and/or 100 objects.	**All students should** • Develop an understanding of the order of magnitude (size) of whole numbers and use this knowledge to estimate quantities.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Select a reasonable order of magnitude for a given set from three given quantities: a one-digit numeral, a two-digit numeral, and a three-digit numeral (e.g., 5, 50, and 500 jelly beans in jars) in a familiar problem situation. • Given a familiar problem situation involving magnitude, explain why a particular estimate was chosen as the most reasonable from three given quantities: a one-digit numeral, a two-digit numeral, and a three-digit numeral.

1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Associate the terms *addition*, *adding*, and *sum* with the concept of joining or combining. • Associate the terms *subtraction*, *subtracting*, *minus*, and *difference* with the process of ~~"~~taking away~~"~~ or separating (i.e., removing a set of objects from the given set of objects, finding the difference between two numbers, or comparing two numbers). • Provide practice in the use and selection of strategies. Encourage students to develop efficient strategies. Examples of strategies for developing the basic addition and subtraction facts include – counting back; – "one-more-than," "two-more-than" facts; – "one-less-than," "two-less-than" facts; – "doubles" to recall addition facts (e.g., 2 + 2 =__; 3 + 3 =__); – "near doubles" [e.g., 3 + 4 = (3 + 3) + 1 = __]; – "make-ten" facts (e.g., at least one addend of 8 or 9); – "think addition for subtraction" (e.g., for 9 – 5 = __, think "5 and what number makes 9?"); – use of the commutative property, without naming the property (e.g., 4 +3 is the same as 3 + 4); – use of ~~fact families~~ related facts (e.g., 4 + 3 = 7 , 3 + 4 = 7, 7 – 4 = 3, and 7 – 3 = 4); – use of the ~~zero property~~ additive identity property (e.g., 4 + 0 = 4), without naming the property but saying, "When you add zero to a number, you always get the original number." – use patterns to make sums (e.g., 0 + 5 = 5, 1 + 4 = 5, 2 + 3 = 5, etc.) • Manipulatives should be used ~~initially~~ to develop an understanding of addition and subtraction facts ~~and to engage students in meaningful memorization~~. ~~Rote~~	**All students should** • Develop an understanding of the addition and subtraction relationship. • Develop addition and subtraction strategies for fact recall. • Develop fluency with basic number combinations for addition and subtraction.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify + as a symbol for addition, ~~and~~ – as a symbol for subtraction, and = as a symbol for equality. • Recall and state orally the basic addition facts for sums with two addends to ~~10~~ 18 or less and the corresponding subtraction facts. • Recall and write the basic addition facts for sums to ~~10~~ 18 or less and the corresponding subtraction facts, when addition or subtraction problems are presented in either horizontal or vertical written format.

1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~recall~~ Automaticity of ~~the~~ facts ~~is often~~ can be achieved through constant practice ~~and may come in a variety of formats, including presentation through flash cards, practice sheets, and/or games~~ which may include games, hands-on activities, flash cards, and paper and pencil. • Students should first master facts to 10 and then master facts to 18.		

1.6 The student will create and solve one-step story and picture problems using basic addition facts with sums to 18 or less and the corresponding subtraction facts.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The problem solving process is enhanced when students – create their own story problems; and – model word problems, using manipulatives, ~~or drawings~~ representations, or number sentences/equations. • Students should ~~be exposed to~~ experience a variety of problem types related to addition and subtraction, including – join and separate problems (action involved); join (for example: Sam had 8 pennies. Tom gave him 3 more. How many pennies does Sam have now? separate (for example: Sam had 11 pennies. He gave 3 to Tom. How many pennies does Sam have now?) – part-part-whole problems (no action involved); missing part (for example: There are 8 marbles. Five are shown. How many are missing?) – classification problems (for example: Jane had 12 hats. Only ~~three~~ 3 of the hats are blue. How many are not blue?) – comparison problems (for example: Bill is 7 years old. Alice is 4 years old. How much younger is Alice than Bill?).	**All students should** • Understand various meanings of addition and subtraction in a variety of situations. • Understand that creating and solving problems involves the use of addition and/or subtraction.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Interpret and solve oral or written story and picture problems involving one-step solutions, using basic addition and subtraction facts (sums to ~~10~~ 18 or less and the corresponding subtraction facts). • Identify a correct number sentence to solve an oral or written story ~~or~~ and picture problem, selecting from among basic addition and subtraction facts.

Measurement is important because it helps to quantify the world around us and is useful in so many aspects of everyday life. Students in grades K–3 should encounter measurement in many normal situations, from their daily use of the calendar and from science activities that often require students to measure objects or compare them directly, to situations in stories they are reading and to descriptions of how quickly they are growing.

Measurement instruction at the primary level focuses on developing the skills and tools needed to measure length, weight/mass, capacity, time, temperature, area, perimeter, volume, and money. Measurement at this level lends itself especially well to the use of concrete materials. Children can see the usefulness of measurement if classroom experiences focus on estimating and measuring real objects. They gain deep understanding of the concepts of measurement when handling the materials, making physical comparisons, and measuring with tools.

As students develop a sense of the attributes of measurement and the concept of a measurement unit, they also begin to recognize the differences between using nonstandard and standard units of measure. Learning should give them opportunities to apply both techniques and nonstandard and standard tools to find measurements and to develop an understanding of the use of simple U.S. Customary and metric units.

Teaching measurement offers the challenge to involve students actively and physically in learning and is an opportunity to tie together other aspects of the mathematical curriculum, such as fractions and geometry. It is also one of the major vehicles by which mathematics can make connections with other content areas, such as science, health, and physical education.

1.7 The student will

a) identify the number of pennies equivalent to a nickel, a dime, and a quarter; and

b) determine the value of a collection of pennies, nickels, and dimes whose total value is 100 cents or less.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Many experiences with coins help students develop an understanding of money, such as – drawing pennies to show the value of a given coin (e.g., a nickel, a dime, or a quarter); – playing store and purchasing classroom objects, using play money (pennies); – representing the value of a nickel, a dime, and a quarter, using pennies; and – trading the equivalent value of pennies for a nickel, a dime, and a quarter, using play money. • Counting money helps students gain an awareness of consumer skills and the use of money in everyday life. • A variety of classroom experiences in which students manipulate physical models of money and count forward to determine the value of a collection of coins are important activities to ensure competence with counting money. • Establishing a one-to-one correspondence between the number names and the items in a set of coins (pennies, nickels, or dimes) is essential for an accurate count. • The last number stated represents the value of a collection of coins being counted. This is known as the cardinality of the set.	**All students should** • Develop an understanding of exchanging the appropriate number of pennies for a nickel, a dime, or a quarter. • <u>Develop an understanding of place value by skip counting a collection of coins by ones, fives, and tens.</u>	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the value of a nickel, a dime, and a quarter in terms of pennies. • Recognize the characteristics of pennies, nickels, and dimes (e.g., color, size). • Count by ones to determine the ~~total~~ value of a collection of pennies whose total value is 100 cents or less. • Count by fives to determine the ~~total~~ value of a collection of nickels whose total value is 100 cents or less. • Count by tens to determine the ~~total~~ value of a collection of dimes whose total value is 100 cents or less. • <u>Count by ones, fives, and tens to determine the value of a collection of pennies and nickels, pennies and dimes, and nickels and dimes whose total value is 100 cents or less.</u> • <u>Count by ones, fives, and tens to determine the value of a collection of pennies, nickels, and dimes whose total value is 100 cents or less.</u> • ~~Identify the value of a collection of pennies, nickels, and dimes, whose total value is 100 cents or less.~~

1.8 The student will tell time to the half-hour, using analog and digital clocks.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Many experiences using clocks help students develop an understanding of the telling of time to the half-hour, including – identifying the parts of an analog clock (minute and hour hands); – demonstrating a given time to the half-hour, using a model clock; – writing correct digital time to the half-hour; and – relating time on the half-hour to daily routines and school schedules (e.g., the times of TV programs, bedtime, resource time, lunch time, recess time).	**All students should** • Understand how to tell time to the half-hour, using an analog ~~or~~ <u>and</u> digital clock. • <u>Understand the concepts of a.m., p.m., minutes, and hours.</u> • <u>Understand that there are sixty minutes in an hour.</u>	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Tell time shown on an analog clock to the half-hour. • Tell time shown on a digital clock to the half-hour. • Match a written time to the time shown on a digital ~~or~~ <u>and</u> analog clock to the half-hour.

1.9 The student will use nonstandard units to measure length, weight/mass, and volume.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The process of measurement involves selecting a unit of measure, comparing the ~~object to be measured to the~~ unit to the object to be measured, counting the number of times ~~the object can be measured by~~ the unit is used to measure the object, and arriving at an approximate total number of units. • Premature use of instruments or formulas leaves children without the understanding necessary for solving measurement problems. • When children's initial explorations of length, weight/mass, and volume involve the use of nonstandard units, they develop some understanding about the need for standard measurement units for length, weight/mass, and volume especially when they communicate about these measures.	**All students should** • Understand that measurement involves comparing an attribute of an object to the same attribute of the unit of measurement (e.g., the length of a cube measures the length of a book. The weight/mass of the cube measures the weight/mass of the book. The volume of the cube measures the volume of a book). • Understand how to measure length, weight/mass, and volume using various nonstandard units of measurement.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Measure the length of objects, using various nonstandard units (e.g., connecting cubes, paper clips, erasers). • Measure the weight/mass of objects, using a balance scale with various nonstandard units (e.g., paper clips, bean bags, cubes). • Measure the volume of objects, using various nonstandard units (e.g., connecting cubes, blocks, rice, water).

1.10 The student will compare, using the concepts of more, less, and equivalent,
a) the volumes of two given containers; and
b) the weight/mass of two objects, using a balance scale.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Estimation is a commonly used strategy to compare the volumes of two containers. • Determining the volume of a container by counting the number of nonstandard units (e.g., a spoonful, or scoopful~~, or teacupful~~ of concrete material, such as jelly beans, sand, water, or rice) that can be held by the container is a precursor to comparing volumes. • A variety of activities that focus on directly comparing the volume of objects leads to an understanding of volume. • The level of difficulty in measuring volume can be increased by varying and mixing the sizes of the containers (e.g., using short, wide containers as well as tall, narrow containers). • Weight and mass are different. Mass is the amount of matter in an object. Weight is determined by the pull of gravity on the mass of an object. The mass of an object remains the same regardless of its location. The weight of an object changes dependent on the gravitational pull at its location. In everyday life, most people are actually interested in determining an object's mass, although they use the term *weight* (e.g., "How much does it weigh?" versus "What is its mass?"). • Balance scales are instruments used for ~~weighing~~ comparing weight/mass. A balance scale usually has a beam that is supported in the center. On each side of the beam are two identical trays. When the trays hold equal	**All students should** • Understand how to fill containers with objects to determine their volume and compare the volumes of two containers. • Understand that a balance ~~beam~~ scale can be used to compare the weights of two objects using the terms more, less, or equivalent.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare the volumes of two containers to determine if the volume of one is ~~greater than~~ more, less ~~than~~, or ~~the same as~~ equivalent to the other, using nonstandard units of measure (e.g., a spoonful~~,~~ or scoopful~~, or teacupful~~). • Compare the volumes of two containers to determine if the volume of one is ~~greater than~~ more, less ~~than~~, or ~~the same as~~ equivalent to the other by pouring the contents of one container into the other. • Compare the weight/mass of two objects, using the terms *lighter, heavier*, or *the same*, using a balance scale. The pan containing less weight/mass will rise and the pan containing more weight/mass will fall. If the objects are of equivalent weight/mass, the two pans will balance.

1.10 The student will compare, using the concepts of more, less, and equivalent,
a) the volumes of two given containers; and
b) the weight/mass of two objects, using a balance scale.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
weights, the beam is level, and the scale is "balanced." • Physically measuring the weights of objects, using a balance scale, helps students develop an intuitive idea of what it means to say something is "lighter," "heavier," or "the same." • Experience estimating the weights of two objects (one in each hand) using the terms lighter, heavier, or the same promotes an understanding of the concept of balance.		

1.11 The student will use calendar language appropriately (e.g., names of the months, *today, yesterday, next week, last week*).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Time is a unit of measure.~~ • ~~Real-life~~ Practical situations are appropriate to develop a sense of the interval of time between events (e.g., Boy Scout meetings occur every week on Monday: there is a week between meetings). • The calendar is a way to represent ~~measure~~ units of time (e.g., days, weeks, and months). • Using a calendar develops the concept of day as a 24-hour period rather than a period of time from sunrise to sunset.	**All students should** • Understand how to use a calendar as a way to measure time.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Read a calendar to locate a given day or date. • Identify the months of the year. • Identify the seven days in a week. • Determine the days/dates before and after a given day/date (e.g., yesterday, today, tomorrow). • Determine the date that is a specific number of days or weeks in the past or in the future from a given date, using a calendar. • Identify specific dates (e.g., the third Monday in a given month).

Children begin to develop geometric and spatial knowledge before beginning school, stimulated by the exploration of ~~shapes~~ figures and structures in their environment. Geometric ideas help children systematically represent and describe their world as they learn to represent ~~two- and three-dimensional~~ plane and solid ~~shapes~~ figures through drawing, block constructions, dramatization, and verbal language.

The focus of instruction at this level is on

- observing, identifying, describing, comparing, contrasting and investigating ~~three-dimensional~~ solid objects and their ~~two-dimensional~~ faces;
- sorting objects and ordering them directly by comparing them one to the other;
- describing, comparing, contrasting, sorting, and classifying ~~shapes~~ figures; and
- exploring symmetry, congruence, and transformation.

In the primary grades, children begin to develop basic vocabulary related to these ~~shapes~~ figures but do not develop precise meanings for many of the terms they use until they are thinking beyond Level 2 of the van Hiele theory (see below).

The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.)

1.12 The student will identify and trace, describe, and sort plane geometric figures (triangle, square, rectangle, and circle) according to number of sides, vertices, and right angles.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A plane geometric figure is any two-dimensional closed ~~shape~~ figure. Circles and polygons are examples of plane geometric figures. • The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding. – **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons. – **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same (e.g., "I know it's a rectangle because it looks like a door, and I know that a door is a rectangle"). – **Level 2: Analysis.** Properties are perceived, but are isolated and unrelated. Students should recognize and name properties of geometric figures (e.g., "I know it's a rectangle because it is closed; it has four sides and four right angles, and opposite sides are parallel."). • Students should have experiences with various plane geometric polygons. – Triangles could be equilateral, right,	**All students should** • Develop strategies to sort and/or group plane geometric figures and refine the vocabulary used to explain their strategies.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe a circle. • ~~Draw~~ Trace triangles, squares, rectangles, and circles. • Describe triangles, squares, and rectangles by the number of sides, ~~corners, and square corners~~ vertices, and right angles. • Sort plane geometric figures into appropriate subsets (categories) based on characteristics (number of sides, vertices, angles, curved, etc.). • Identify the name of the ~~shape~~ geometric figure when given information about the number of sides, ~~corners, and/or square corners~~ vertices, and right angles.

1.12 The student will identify and trace, describe, and sort plane geometric figures (triangle, square, rectangle, and circle) according to number of sides, vertices, and right angles.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
obtuse, acute, etc. – Quadrilaterals could be rectangles, squares, trapezoids, rhombi, etc. • A vertex is the point at which two line segments, lines, or rays meet to form an angle. • A polygon is a plane geometric figure which – has sides that are ~~straight~~ line segments; – is simple (its sides do not cross); – is closed; and – is two-dimensional (~~it~~ lies in a plane). • A triangle is a polygon with three angles and three sides. • A quadrilateral is a polygon with four sides. • A rectangle is a quadrilateral with four right angles. • A square is a rectangle with four sides of equal length. • A circle is a closed curve with all points in one plane and the same distance from a fixed point (the center). • ~~Translations~~ Transformations (~~slides~~ translations, ~~flips~~ reflections, and ~~turns~~ rotation) can be used to change the location of objects. • Presentation of triangles, rectangles, and squares should be made in a variety of spatial orientations so that students do not develop the common misconception that triangles, rectangles, and squares must have one side parallel to the bottom of the page on which they are printed.		

1.13 The student will construct, model, and describe objects in the environment as geometric shapes (triangle, rectangle, square, and circle) and explain the reasonableness of each choice.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Representations of circles, squares, rectangles, and triangles can be found in the students' environment at school and at home. Students should have opportunities to identify/classify things in the~~ir~~ environment by the type of ~~shape~~ figure those things represent. • ~~Children are often confused~~ A common misconception students have when a ~~shape~~ figure such as a square is rotated~~:~~ is they will frequently refer to the rotated square as a diamond. Clarification needs to be ongoing — i.e., a square is a square regardless of its location in space; there is no such geometric ~~shape~~ figure as a diamond. • Building geometric and spatial capabilities fosters enthusiasm for mathematics while providing a context to develop spatial sense. • Polygons can be constructed using other polygons (e.g., six equilateral triangles can be used to construct a hexagon, a triangle can be added to a rectangle to create a pentagon, etc.).	**All students should** • Understand that geometric figures are integral parts of ~~his/her~~ the environment. • Use familiarity with the figure, structure, and location to develop spatial reasoning.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Construct plane geometric figures. • Identify models of representations of circles, squares, rectangles, and triangles in the environment at school and home and tell why they represent those ~~shapes~~ figures. • Describe representations of circles, squares, rectangles, and triangles in the environment and explain the reasonableness of the choice ~~(e.g., "I know it's a rectangle because it looks like a door, and I know that a door is a rectangle.")~~.

Students in the primary grades have a natural curiosity about their world, which leads to questions about how things fit together or connect. They display their natural need to organize things by sorting and counting objects in a collection according to similarities and differences with respect to given criteria.

The focus of probability instruction at this level is to help students begin to develop an understanding of the concept of chance. They experiment with spinners, two-colored counters, dice, tiles, coins, and other manipulatives to explore the possible outcomes of situations and predict results. They begin to describe the likelihood of events, using the terms *impossible, unlikely, equally likely, more likely,* and *certain.*

The focus of statistics instruction at this level is to help students develop methods of collecting, organizing, describing, displaying, and interpreting data to answer questions they have posed about themselves and their world.

1.14 The student will investigate, identify, and describe various forms of data collection (e.g., recording daily temperature, lunch count, attendance, favorite ice cream), using tables, picture graphs, and object graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Students' questions about the physical world can often be answered by collecting data and observing the results. • Data are information collected about people or things. The primary purpose of collecting data is to answer questions. • After generating questions, students decide what information is needed and how it can be collected. • The collection of the data often leads to new questions to be investigated. • The entire process broadens children's views of mathematics and its usefulness. • Data collection could involve voting, informal surveys, tallying, and charts. • Surveys, which are data-collecting tools that list choices, should have a limited number of questions at the primary grades. • Tallying is a method for gathering information. Tally marks are used to show how often something happens or occurs. Each tally mark represents one occurrence. Tally marks are clustered into groups of five, with four vertical marks representing the first four occurrences and the fifth mark crossing the first four on a diagonal to represent the fifth occurrence.	**All students should** • Understand how data can be collected and presented in an organized manner. • Understand that data gathered and analyzed from observations and surveys can have an impact on our everyday lives.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Investigate various forms of data collection, including counting and tallying, informal surveys, observations, and voting. • Identify and describe various forms of data collection in ~~his or her world~~ practical situations (e.g., recording daily temperature, lunch count, attendance, and favorite ice cream.)

1.15 The student will interpret information displayed in a picture or object graph, using the vocabulary *more, less, fewer, greater than, less than,* and *equal to*.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Statistics is used to describe and interpret with numbers the world around us; it is a tool for problem solving. • Students' questions about everyday life can often be answered by collecting and interpreting data. • Organized data provides a clearer picture for interpretation. Data may be described in object graphs and picture graphs. • Picture graphs are graphs that use pictures to show and compare information. ~~A key is often used to indicate what each picture represents (e.g., one picture of a dog represents five dogs).~~ • Object graphs are graphs that use concrete materials to represent the categorical data that are collected (e.g., cubes stacked by the month, with one cube representing the birthday month of each student). • Interpretation of the data could lead to additional questions to be investigated.	**All students should** • Understand that picture graphs use pictures to represent and compare data while object graphs use concrete objects to represent and compare data. • Understand that data can be analyzed and interpreted, using the terms *more*, *less*, *fewer*, *greater than*, *less than*, and *equal to*.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Demonstrate the meaning of the terms *more*, *less*, *fewer*, *greater than*, *less than*, and *equal to*, using concrete materials.~~ • Compare one category to another in a graph, indicating which has more or which has less, or which is equal to. • Interpret information displayed in object graphs and picture graphs, using the words *more*, *less*, *fewer*, *greater than*, *less than*, and *equal to*. • Find answers to questions, using graphs (e.g., "Which category has more?" ~~"Which category has less"~~, "How many more?", and "How many in all?").

Stimulated by the exploration of their environment, children begin to develop concepts related to patterns, functions, and algebra before beginning school. Recognition of patterns and comparisons are important components of children's mathematical development.

Students in kindergarten through third grade develop the foundation for understanding various types of patterns and functional relationships through the following experiences:

- sorting, comparing, and classifying objects in a collection according to a variety of attributes and properties;
- identifying, analyzing, and extending patterns;
- creating repetitive patterns and communicating about these patterns in their own language;
- analyzing simple patterns and making predictions about them;
- recognizing the same pattern in different representations;
- describing how both repeating and growing patterns are generated; and
- repeating predictable sequences in rhymes and extending simple rhythmic patterns.

The focus of instruction at the primary level is to observe, recognize, create, extend, and describe a variety of patterns ~~in the real world~~. These students will experience and recognize visual, kinesthetic, and auditory patterns and develop the language to describe them orally and in writing as a foundation to using symbols. They will use patterns to explore mathematical and geometric relationships and to solve problems, and their observations and discussions of how things change will eventually lead to the notion of functions and ultimately to ~~A~~algebra.

1.16 The student will sort and classify concrete objects according to one or more attributes, including color, size, shape, and thickness.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Sorting, classifying, and ordering objects facilitate work with patterns, geometric shapes, and data. • To classify is to arrange or organize a set of materials according to a category or attribute (a quality or characteristic ~~of a thing~~). • General similarities and differences among items are easily observed by primary students, who can begin to focus on more than one attribute at a time. During the primary grades, the teacher's task is to move students toward a more sophisticated understanding of classification in which two or more attributes connect or differentiate sets, such as those found in nature (e.g., leaves with different colors and different shapes).	**All students should** • Understand the same set of objects can be sorted and classified in different ways.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Sort and classify objects into appropriate subsets (categories) based on one or two attributes, such as size, shape, color, or thickness.

1.17 The student will recognize, describe, extend, and create a wide variety of growing and repeating patterns.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Patterns allow children to recognize order, ~~to~~ generalize, and ~~to~~ predict. • Patterning should include – reproducing a given pattern, using manipulatives; – recording a pattern with pictures or symbols; – transferring a pattern into a different form or different representation (e.g., blue–blue–red to an AAB repeating pattern); and – analyzing patterns in ~~the real world~~ practical situations (e.g., calendar, seasons, days of the week). • The simplest types of patterns are repeating patterns. The part of the pattern that repeats is the core. The patterns can be oral, such as the refrain in "Old MacDonald's Farm" ("e-i-e-i-o"), or physical with clapping and snapping patterns, or combinations of both, such as is found in songs like the "Hokey Pokey." In each case, students need to identify the basic unit of the pattern and repeat it. Opportunities to create, recognize, describe, and extend repeating patterns are essential to the primary school experience. • Growing patterns are more difficult for students to understand than repeating patterns because not only must they determine what comes next, they must also begin the process of generalization. Students need experiences with growing patterns in both arithmetic and geometric formats. • Create an arithmetic number pattern. Sample numeric patterns include – 6, 9, 12, 15, 18, …(growing pattern);	**All students should** • Understand that patterns are a way to recognize order, to organize their world, and to predict what comes next in an arrangement. • Recognize and state the core of a pattern. • Analyze how both repeating and growing patterns are generated.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize the pattern in a given rhythmic, color, ~~shape~~ geometric figure, or numerical sequence. • Describe the pattern in a given rhythmic, color, ~~shape~~ geometric figure, or numerical sequence in terms of the core (the part of the sequence that repeats). • Extend a pattern, using manipulatives, geometric figures, numbers, or calculators. • Transfer a pattern from one form to another. • Create a repeating or growing pattern, using manipulatives, geometric figures, numbers, or calculators (e.g., the growing patterns 2, 3, 2, 4, 2, 5, 2, 6, 2, …). • ~~Create an arithmetic number pattern, using a calculator (e.g., when skip counting by fives, use the constant feature on the calculator by pressing 5 + 5 = = = … to produce the pattern 5, 10, 15, 20, …).~~

1.17 The student will recognize, describe, extend, and create a wide variety of growing and repeating patterns.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
– ~~5, 7, 9, 11, 13~~ 20, 18, 16, 14, … (~~repeating numeric~~ growing pattern); ~~and~~ – 1, 2, 4, 7, 11, 16, … (growing ~~numeric~~ pattern)~~.~~; and – 1, 3, 5, 1, 3, 5, 1, 3, 5… (repeating pattern). • In geometric patterns, students must often recognize transformations of a figure, particularly rotation or reflection. Rotation ~~(turn)~~ is the result of turning a figure around a point or a vertex, and reflection ~~(flip)~~ is the result of flipping a figure over a line.		

1.18 The student will demonstrate an understanding of equality through the use of the equal sign.

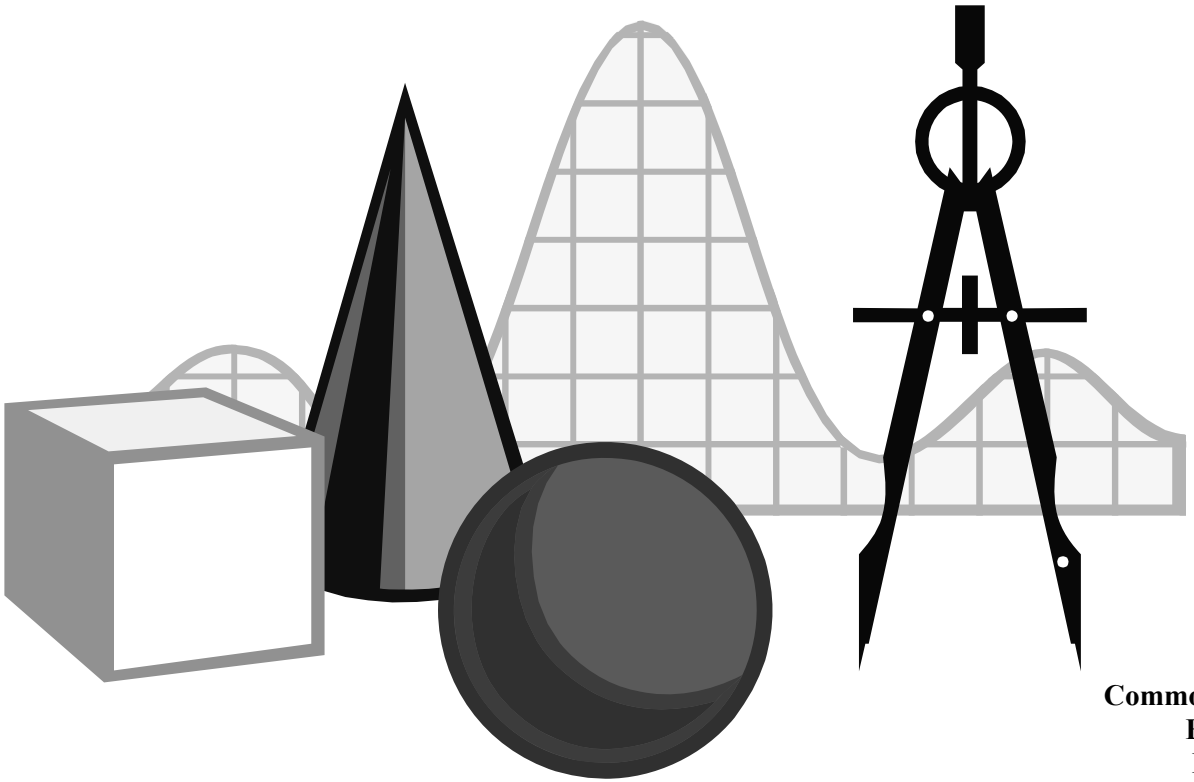
UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Equality can be shown by measuring with a balance scale or a number balance. • Manipulatives such as rods, connecting cubes, and counters can be used to model equations. • An expression is a representation of a quantity. It is made up of numbers, variables, and/or computational symbols. It does not have an equal sign (e.g., x + 3). • An equation is a mathematical statement that two expressions are the same. Equations are written with an equal sign. • ~~Equations are not equal.~~ Equations have expressions of equal value on both sides (e.g., 5 + 3 = 8, 8 = 5 + 3 and 4 + 3 = 9 - 2). • An equation can be represented using ~~must be~~ balanc~~ed~~ scales. There must be the same amount on each side of an equal sign (e.g., 5 + 3 = 3 + 5). • A common misunderstanding is that the equal sign always means the answer. The equal sign can represent an equality. • Equations should be shown in many different forms (e.g., 6 = 6, 4 + 2 = 6, 5 + 1 = 4 + 2, 6 = 4 + 2, 4 = 6 - 2). • Inequalities such as 5 < 4 + 3 are not equations. Equations must have the equal sign. • It is important for children to understand that the expression 3 + 5 is another representation of eight. • The equal sign is used when two representations name the same number, 5 + 3 = 10 - 2. These	**All students should** • Understand that the equal sign means "is the same as" or "another name for" or "equal in value". • Understand that equality represents a balance concept. Both sides of the equation balance because they are equal (they have the same value).	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the equality (=) symbol. • Recognize that the equations 4 + 2 = 2 + 4 and 6 + 1= 4 + 3 represent the relationship between two expressions of equal value. • Model an equation that represents the relationship of two ~~an~~ expressions of equal value. • Identify equivalent values (e.g., 3 = 3, 4 + 3 = 8 - 1, 7 = 2 + 5, etc.).

1.18 The student will demonstrate an understanding of equality through the use of the equal sign.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
two expressions in the equation represent the same number, eight. • Equations should be routinely modeled in conjunction with story problems. • Solving missing addend problems and stories helps with the understanding of equality and the equal sign (e.g., There are ~~four~~ 4 red birds in the tree. Some black birds fly to the tree. Now there are six birds in the tree. How many black birds flew to the tree? 4+__ =6)		

MATHEMATICS STANDARDS OF LEARNING CURRICULUM FRAMEWORK

Grade 2



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The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

Students in grades K–3 have a natural curiosity about their world, which leads them to develop a sense of number. Young children are motivated to count everything around them and begin to develop an understanding of the size of numbers (magnitude), multiple ways of thinking about and representing numbers, strategies and words to compare numbers, and an understanding of the effects of simple operations on numbers. Building on their own intuitive mathematical knowledge, they also display a natural need to organize things by sorting, comparing, ordering, and labeling objects in a variety of collections.

Consequently, the focus of instruction in the number and number sense strand is to promote an understanding of counting, classification, whole numbers, place value, ~~simple~~ fractions, number relationships ("more than," "less than," and "~~as many as~~ equal to"), and the effects of ~~simple~~ single-step and multistep computations ~~operations on numbers (fact families)~~. These learning experiences should allow students to engage actively in a variety of problem solving situations and to model numbers (compose and decompose), using a variety of manipulatives. Additionally, students at this level should have opportunities to observe, to develop an understanding of the relationship they see between numbers, and to develop the skills to communicate these relationships in precise, unambiguous terms.

2.1 The student will

a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models;
b) round two-digit numbers to the nearest ten; and
c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The number system is based on a simple pattern of tens where each place has ten times the value of the place to its right. • Opportunities to experience the relationships among hundreds, tens, and ones through hands-on experiences with manipulatives are essential to developing the ten-to-one place value concept of our number system and to understanding the value of each digit in a three-digit number. Ten-to-one trading activities with manipulatives on place value mats provide excellent experiences for developing the understanding of the places in the ~~b~~Base-10 system. • Models that clearly illustrate the relationships among hundreds, tens, and ones are physically proportional (e.g., the tens piece is ten times larger than the ones piece). • Students need to understand that 10 and 100 are special units of numbers (e.g., 10 is 10 ones, but it is also 1 ten). • Flexibility in thinking about numbers is critical. For example, 123 is 123 ones; or 1 hundred, 2 tens, and 3 ones; or 12 tens and 3 ones. • Rounding is finding the nearest easy-to-use number (e.g., the nearest 10) for the situation at hand. • Number lines are useful tools for developing the concept of rounding to the nearest ten. ~~Students can use the strategy of identifying a number on a~~	**All students should** • Understand the ten-to-one relationship of ones, tens, and hundreds (10 ones equals 1 ten; 10 tens equals 1 hundred). • Understand that numbers are written to show how many hundreds, tens, and ones are in the number. • Understand that rounding gives a close, easy-to-use number to use when an exact number is not needed for the situation at hand. • Understand that a knowledge of place value is essential when comparing numbers. • Understand the relative magnitude of numbers by comparing numbers.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Demonstrate the understanding of the ten-to-one relationships among ones, tens, and hundreds, using manipulatives (e.g., beans and cups, ~~b~~Base-10 blocks, bundles of 10 ~~Popsicle~~ sticks). • Determine the place value of each digit in a three-digit numeral presented as a pictorial representation (e.g., a picture of ~~b~~Base-10 blocks) or as a physical representation (e.g., actual ~~b~~Base-10 blocks). • Write numerals, using a ~~b~~Base-10 model or picture. • Read three-digit numbers when shown a numeral, a ~~b~~Base-10 model of the number, or a pictorial representation of the number. • Identify the place value (ones, tens, hundreds) of each digit in a three-digit numeral. • Determine the value of each digit in a three-digit numeral (e.g., in 352, the 5 represents 5 tens and its value is 50). • Round two-digit numbers to the nearest ten. • Compare two numbers between 0 and 999 represented pictorially or with concrete objects (e.g., ~~b~~Base-10 blocks), using the words *greater than, less than* or *equal to*.

2.1 The student will

a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models;
b) round two-digit numbers to the nearest ten; and
c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~number line and finding the multiple of ten that is closest to the identified number.~~ Rounding to the nearest ten using a number line is done as follows: – Locate the number on the number line. – Identify the two tens the number comes between. – Determine the closest ten. – If the number in the ones place is 5 (halfway between the two tens), round the number to the higher ten. • ~~A strategy~~ Once the concept for rounding numbers using a number line is developed, the procedure for rounding numbers to the nearest ten is as follows: – Look one place to the right of the digit in the place you wish to round to. – If the digit is less than 5, leave the digit in the rounding place as it is, and change the digit to the right of the rounding place to zero. – If the digit is 5 or greater, add 1 to the digit in the rounding place, and change the digit to the right of the rounding place to zero. • A procedure for comparing two numbers by examining place value may include the following: – Line up the numbers by place value lining up the ones. – Beginning at the left, find the first place value where the digits are different. – Compare the digits in this place value to determine which number is greater (or which is less). – Use the appropriate symbol > or < or words *greater than* or *less than* to compare the numbers in the order in which they are		

2.1 The student will

a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models;
b) round two-digit numbers to the nearest ten; and
c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
presented. – If both numbers are the same, use the symbol = or the words *equal to*. • Mathematical symbols (>, <) used to compare two unequal numbers are called *inequality symbols*.		

2.2 The student will

a) identify the ordinal positions first through twentieth, using an ordered set of objects; and

b) write the ordinal numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Understanding the cardinal and ordinal meanings of numbers is necessary to quantify, measure, and identify the order of objects. • An ordinal number is a number that names the place or position of an object in a sequence or set (e.g., first, third). *Ordered position*, *ordinal position*, and *ordinality* are terms that refer to the place or position of an object in a sequence or set. • The ordinal position is determined by where one starts in an ordered set of objects or sequence of objects (e.g., left, right, top, bottom). • The ordinal meaning of numbers is developed by identifying and verbalizing the place or position of objects in a set or sequence (e.g., a student's position in line when students are lined up alphabetically by first name). • Ordinal position can also be emphasized through sequencing events (e.g., months in a year or sequencing in a story). • Cardinality can be compared with ordinality when comparing the results of counting. There is obvious similarity between the ordinal number words *third* through *twentieth* and the cardinal number words *three* through *twenty*.	**All students should** • Use ordinal numbers to describe the position of an object in a sequence or set.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Count an ordered set of objects, using the ordinal number words *first* through *twentieth*. • Identify the ordinal positions first through twentieth, using an ordered set of objects. • Identify the ordinal positions first through twentieth, using an ordered set of objects presented in lines or rows from – left to right; – right to left; – top to bottom; and – bottom to top. • Write 1st, 2nd, 3rd, through 20th in numerals.

2.3 The student will

a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths;
b) write the fractions; and
c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The whole should be defined. • A fraction is a way of representing part of a whole (as in a region/area model) or part of a group (as in a set model). • In each fraction model, the parts must be equal (i.e., each pie piece must have the same area; the size of each chip in a set must be equal). In problems with fractions, a whole is broken into equal-size parts and reassembled into one whole. • Students should have experiences dividing a whole into additional parts. As the whole is divided into more parts, students understand that each part becomes smaller. • The denominator ~~(bottom number)~~ tells how many equal parts are in the whole or set. The numerator ~~(top number)~~ tells how many of those parts are being described. • Students should have opportunities to make connections among fraction representations by connecting concrete or pictorial representations with spoken or symbolic representations. • Informal, integrated experiences with fractions at this level will help students develop a foundation for deeper learning at later grades. Understanding the language of fractions (e.g., *thirds* means "three equal parts of a whole" or $\frac{1}{3}$ represents one of three equal-size parts when a pizza is shared among three	**All students should** • Understand that fractional parts are equal shares of a whole or a whole set. • Understand that the fraction name (*half*, *fourth*) tells the number of equal parts in the whole. • Understand that when working with unit fractions, the larger the denominator, the smaller the part and therefore the smaller the fraction.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize fractions as representing equal-size parts of a whole. • Identify the fractional parts of a whole or a set for ~~$\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, and $\frac{1}{10}$~~ $\frac{2}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{2}{6}$, $\frac{7}{8}$, $\frac{7}{10}$, etc. • Identify the fraction names (halves, thirds, fourths, sixths, eighths, tenths) for the fraction notations ~~$\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, and $\frac{1}{10}$~~ $\frac{2}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{2}{6}$, $\frac{7}{8}$, $\frac{7}{10}$, etc. • Represent fractional parts of a whole for ~~$\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, and $\frac{1}{10}$~~ halves, thirds, fourths, sixths, eighths, tenths using – region/area models (e.g., pie pieces, pattern blocks, geoboards); – sets (e.g., chips, counters, cubes); and – measurement models (e.g., fraction strips, ~~cuisenaire~~ rods, connecting cubes). • Compare unit fractions ($\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, and $\frac{1}{10}$) using the words *greater than*, *less than* or *equal to*

2.3 The student will

a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths;
b) write the fractions; and
c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
students) will further this development. • A unit fraction is one in which the numerator is one. • Using models when comparing unit fractions will assist in developing the concept that the larger the denominator the smaller the piece; therefore, $\frac{1}{3} > \frac{1}{4}$.		and the symbols (>, <, =).

2.4 The student will

a) count forward by twos, fives, and tens to 100, starting at various multiples of 2, 5, or 10;
b) count backward by tens from 100; and
c) recognize even and odd numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The patterns developed as a result of grouping and/or skip counting are precursors for recognizing numeric patterns, functional relationships, and concepts underlying money, time telling, multiplication, and division. Powerful models for developing these concepts include counters, hundred chart, and calculators. • Skip counting by twos supports the development of the concept of even numbers. • Skip counting by fives lays the foundation for reading a clock effectively and telling time to the nearest five minutes, counting money, and developing the multiplication facts for five. • Skip counting by tens is a precursor for use of place value, addition, counting money, and multiplying by multiples of 10. • Calculators can be used to display the numeric patterns resulting from skip counting. Use the constant feature of the four-function calculator to display the numbers in the sequence when skip counting by that constant. ~~For example, when skip counting by twos, press 2 + 2 = = = … to produce 2, 4, 6, 8, 10, …; or when skip counting by fives, press 5 + 5 = = = … to produce 5, 10, 15, ….~~ • Odd and even numbers can be explored in different ways (e.g., dividing collections of objects into two equal groups or pairing objects).	**All students should** • Understand that collections of objects can be grouped and skip counting can be used to count the collection. • Describe patterns in skip counting and use those patterns to predict the next number in the counting sequence. • Understand that the starting point for skip counting by 2 does not always begin at 2. • Understand that the starting point for skip counting by 5 does not always begin at 5. • Understand that the starting point for skip counting by 10 does not always begin at 10. • Understand that every counting number is either even or odd.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine patterns created by counting by twos, fives, and tens on a hundred chart. • Skip count by twos, fives, and tens to 100, using manipulatives, a hundred chart, mental mathematics, a calculator, and/or paper and pencil. • Skip count by twos, fives, and tens to 100~~, using the constant feature on the calculator~~. • Count backward by tens from 100. • ~~Group objects by threes.~~ • ~~Group objects by fours.~~ • Use objects to determine whether a number is odd or even.

A variety of contexts are necessary for children to develop an understanding of the meanings of the operations such as addition and subtraction. These contexts often arise from real-life experiences in which they are simply joining sets, taking away or separating from a set, or comparing sets. These contexts might include conversations, such as "How many books do we have altogether?" or "How many cookies are left if I eat two?" or "I have three more candies than you do." Although young children first compute using objects and manipulatives, they gradually shift to performing computations mentally or using paper and pencil to record their thinking. Therefore, computation and estimation instruction in the early grades revolves around modeling ~~and~~, discussing, and recording a variety of problem situations. This approach ~~to~~ helps students ~~move~~ transition from the concrete to the representation to the symbolic ~~the abstract~~ ~~and~~ in order to develop meaning for the operations and how they relate to each other.

In grades K–3, computation and estimation instruction focuses on

- relating the mathematical language and symbolism of operations to problem situations;
- understanding different meanings of addition and subtraction of whole numbers and the relation between the two operations;
- developing proficiency with basic addition, subtraction, multiplication, division ~~facts~~ and related facts ~~families~~;
- gaining facility in manipulating whole numbers to add and subtract and in understanding the effects of the operations on whole numbers;
- developing and using strategies and algorithms to solve problems and choosing an appropriate method for the situation;
- choosing, from mental computation, estimation, paper and pencil, and calculators, an appropriate way to compute;
- recognizing whether numerical solutions are reasonable;
- experiencing situations that lead to multiplication and division, such as equal groupings of objects and sharing equally; and
- performing initial operations with fractions ~~and decimals~~.

2.5 The student will recall addition facts with sums to 20 or less and the corresponding subtraction facts.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Associate the terms *addition, adding,* and *sum* with the concept of joining or combining. • Associate the terms *subtraction, subtracting, minus*, and *difference* with the process of "taking away" or separating (i.e., removing a set of objects from the given set of objects, finding the difference between two numbers, or comparing two numbers). • Provide practice in the use and selection of strategies. Encourage students to develop efficient strategies. Examples of strategies for developing the basic addition and subtraction facts include – counting on; – counting back; – "one-more-than," "two-more-than" facts; – "one-less-than," "two-less-than" facts; – "doubles" to recall addition facts (e.g., 2 + 2 =__; 3 + 3 =__); – "near doubles" [e.g., 3 + 4 = (3 + 3) + 1 = __]; – "make-ten" facts (e.g., at least one addend of 8 or 9); – "think addition for subtraction," (e.g., for 9 – 5 = __, think "5 and what number makes 9?"); – use of the commutative property, without naming the property (e.g., 4 +3 is the same as 3 + 4); – use of related facts ~~families~~ (e.g., 4 + 3 = 7 , 3 + 4 = 7, 7 – 4 = 3, and 7 – 3 = 4); – use of the ~~zero property~~ additive identity property (e.g., 4 + 0 = 4), without naming the property but saying, "When you add zero to a number, you always get the original number." • Manipulatives should be used initially to develop an understanding of addition and subtraction facts and	**All students should** • Understand that addition involves combining and subtraction involves separating. • Develop fluency in recalling ~~basic~~ facts for addition and subtraction.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Recall and write the basic addition facts for sums to 18 or less and the corresponding subtraction facts.~~ • Recall and write the basic addition facts for sums to ~~18~~ 20 or less and the corresponding subtraction facts, when addition or subtraction problems are presented in either horizontal or vertical written format.

2.5 The student will recall addition facts with sums to 20 or less and the corresponding subtraction facts.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
to engage students in meaningful memorization. Rote recall of the facts is often achieved through constant practice and may come from a variety of formats, including presentation through counting on, related facts, flash cards, practice sheets, and/or games.		

2.6 The student, given two whole numbers whose sum is 99 or less, will
a) estimate the sum; and
b) find the sum, using various methods of calculation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Estimation is a number sense skill used instead of finding an exact answer. When an actual computation is not necessary, an estimate will suffice. • Rounding is one strategy used to estimate. • Estimation is also used before solving a problem to check the reasonableness of the sum when an exact answer is required. • By estimating the result of an addition problem, a place value orientation for the answer is established. • Strategies for mentally adding two-digit numbers ~~mentally~~ include student-invented strategies, making-ten, partial sums and counting on, among others. – partial sums: 56 + 41 = __ 50 + 40 = 90 6 + 1 = 7 90 + 7 = 97 – counting on: 36 + 62 = __ 36 + 60 = 96 96 + 2 = 98 • Addition means to combine or join quantities. • The ~~standard algorithm for addition is~~ terms used in addition are 23 → *addend* + 46 → *addend* 69 → *sum* • Strategies for adding two-digit numbers can include, but are not limited to, using a hundreds chart, number line, and invented strategies.	**All students should** • Understand that estimation skills are valuable, time-saving tools particularly in practical situations when exact answers are not required or needed. • Understand that estimation skills are also valuable in determining the reasonableness of the sum when solving for the exact answer is needed. • Understand that addition is used to join groups in practical situations when exact answers are needed. • Develop flexible methods of adding whole numbers by combining numbers in a variety of ways to find the sum, most depending on place values.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Regroup 10 ones for 1 ten, using ~~b~~Base-10 models, when finding the sum of two whole numbers whose sum is 99 or less. • Estimate the sum of two whole numbers whose sum is 99 or less and recognize whether the estimation is reasonable. • ~~Determine~~ Find the sum of two whole numbers whose sum is 99 or less, using ~~b~~Base-10 models, such as ~~b~~Base-10 blocks and bundles of tens. • Solve problems presented vertically or horizontally that require finding the sum of two whole numbers whose sum is 99 or less, using paper and pencil. • Solve problems, using mental computation strategies, involving addition of two whole numbers whose sum is 99 or less.

2.6 The student, given two whole numbers whose sum is 99 or less, will

a) estimate the sum; and

b) find the sum, using various methods of calculation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Building an understanding of the algorithm by first using concrete materials and then a do-and-write approach connects it to the written form of the algorithm. • The traditional algorithm for two-digit numbers is contrary to the natural inclination to begin with the left-hand number. • Regrouping is used in addition when a sum in a particular place value is 10 or greater.		

2.7 The student, given two whole numbers, each of which is 99 or less, will
a) estimate the difference; and
b) find the difference, using various methods of calculation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Estimation is a number sense skill used instead of finding an exact answer. When an estimate is needed, the actual computation is not necessary. • Rounding is one strategy used to estimate. • Estimation is also used before solving a problem to check the reasonableness of the sum when an exact answer is required. • ~~Giving an estimate of~~ By estimat~~e~~ing the result of a subtraction problem, ~~establishes~~ a place value orientation for the answer is established. • Subtraction is the inverse operation of addition and is used for different reasons: – to remove one amount from another; – to compare one amount to another; and – to find the missing quantity when the whole quantity and part of the quantity are known. • Three terms often used ~~to discuss~~ in subtraction are *minuend* → 98 *subtrahend* → – 41 *difference* → 57 • Regrouping is a process of renaming a number to make subtraction easier. • An understanding of the subtraction algorithm should be built by first using concrete materials and then employing a do-and-write approach (i.e., use the manipulatives, then record what you have done). This connects the activity to the written form of the algorithm. • Mental computational strategies for subtracting two-	**All students should** • Understand that estimation skills are valuable, time-saving tools particularly in practical situations when exact answers are not required or needed. • Understand that estimation skills are also valuable in determining the reasonableness of the difference when solving for the exact answer is needed. • Understand that subtraction is used in practical situations when exact answers are needed. • Develop flexible methods of subtracting whole numbers to find the difference, by combining numbers in a variety of ways, most depending on place values.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Regroup 1 ten for 10 ones, using ~~b~~Base-10 models, such as ~~b~~Base-10 blocks and bundles of tens. • Estimate the difference of two whole numbers each 99 or less and recognize whether the estimation is reasonable. • ~~Determine~~ Find the difference of two whole numbers each 99 or less, using ~~b~~Base-10 models, such as ~~b~~Base-10 blocks and bundles of tens. • Solve problems presented vertically or horizontally that require finding the difference between two whole numbers each 99 or less, using paper and pencil. • Solve problems, using mental computation strategies, involving subtraction of two whole numbers each 99 or less.

2.7 The student, given two whole numbers, each of which is 99 or less, will
a) estimate the difference; and
b) find the difference, using various methods of calculation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
digit numbers might include – lead-digit or front-end strategy: 56 – 21 = __ 50 – 20 = 30 6 – 1 = 5 30 + 5 = 35 – counting up: 87 – 25 = __ 20 + 60 = 80 5 + 2 = 7 60 + 2 = 62 or 87 – 25 = __ 25 + 60 = 85 85 + 2 = 87 60 + 2 = 62 or 87 – 25 = __ 25 + 2 = 27 27 + 60 = 87 2 + 60 = 62 – partial differences: 98 – 41 = __ 90 – 40 = 50 8 – 1 = 7 50 + 7 = 57. • Strategies for subtracting two-digit numbers may include using a hundreds chart, number line, and invented strategies.		

2.8 The student will create and solve one- and two-step addition and subtraction problems, using data from simple tables, picture graphs, and bar graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Problem solving means engaging in a task for which a solution or a method of solution is not known in advance. Solving problems using data and graphs offers a natural way to connect mathematics to practical situations. • The ability to retrieve information from simple charts and picture graphs is a necessary prerequisite to solving problems. • An example of an approach to solving problems is Polya's four-step plan: – Understand: Retell the problem. – Plan: Decide what the operation is. – Solve: Write a number sentence. – Look back: Does the answer make sense? • The problem solving process is enhanced when students – create their own story problems; and – model word problems, using manipulatives or drawings.	**All students should** • Develop strategies for solving practical problems. • Enhance problem solving skills by creating their own problems.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the appropriate data and the operation needed to solve an addition or subtraction problem where the data are presented in a simple table, picture graph, or bar graph. • Solve addition and subtraction problems requiring a one- or two-step solution, using data from simple ~~charts~~ tables, picture graphs, bar graphs, and everyday life situations. • Create a one- or two-step addition or subtraction problem using data from simple tables, picture graphs, and bar graphs whose sum is 99 or less . ~~For subtraction, the difference will be between two whole numbers each 99 or less.~~

2.9 The student will recognize and describe the related facts that represent and describe the inverse relationship between addition and subtraction.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Addition and subtraction are inverse operations, that is, one undoes the other: 3 + 4 = 7 7 – 3 = 4 7 – 4 = 3 4 + 3 = 7 • For each addition fact, there is a related subtraction fact. • Developing strategies for solving missing addends problems and the missing part of subtraction facts ~~(e.g., 7 __ = 3)~~ builds an understanding of the link between addition and subtraction. To solve 9 – 5 = __, think 5 + __ = 9. • Demonstrate joining and separating sets to investigate the relationship between addition and subtraction.	**All students should** • Understand how addition and subtraction relate to one another.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine the missing number in a number sentence (e.g., 3 + __ = 5 or __+ 2 = 5; 5 – __ = 3 or 5 – 2 = __). • Write the related facts for a given addition or subtraction fact (e.g., given 3 + 4 = 7, write 7 – 4 = 3 and 7 – 3 = 4).

Measurement is important because it helps to quantify the world around us and is useful in so many aspects of everyday life. Students in grades K–3 should encounter measurement in many normal situations, from their daily use of the calendar and from science activities that often require students to measure objects or compare them directly, to situations in stories they are reading and to descriptions of how quickly they are growing.

Measurement instruction at the primary level focuses on developing the skills and tools needed to measure length, weight/mass, capacity, time, temperature, area, perimeter, volume, and money. Measurement at this level lends itself especially well to the use of concrete materials. Children can see the usefulness of measurement if classroom experiences focus on estimating and measuring real objects. They gain deep understanding of the concepts of measurement when handling the materials, making physical comparisons, and measuring with tools.

As students develop a sense of the attributes of measurement and the concept of a measurement unit, they also begin to recognize the differences between using nonstandard and standard units of measure. Learning should give them opportunities to apply both techniques and nonstandard and standard tools to find measurements and to develop an understanding of the use of simple U.S. Customary and metric units.

Teaching measurement offers the challenge to involve students actively and physically in learning and is an opportunity to tie together other aspects of the mathematical curriculum, such as fractions and geometry. It is also one of the major vehicles by which mathematics can make connections with other content areas, such as science, health, and physical education.

2.10 The student will

a) count and compare a collection of pennies, nickels, dimes, and quarters whose total value is $2.00 or less; and

b) correctly use the cent symbol (¢), dollar symbol ($), and decimal point (.).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The money system used in the United States consists of coins and bills based on ones, fives, and tens, making it easy to count money. • The dollar is the basic unit. • Emphasis is placed on the verbal expression of the symbols for cents and dollars (e.g., $0.35 and 35¢ are both read as "thirty-five cents"; $3.00 is read as "three dollars"). • Money can be counted by grouping coins and bills to determine the value of each group and then adding to determine the total value. • The most common way to add amounts of money is to "count on" the amount to be added.	**All students should** • Understand how to count and compare a collection of coins and one-dollar bills whose total value is $2.00 or less. • Understand the proper use of the cent symbol (¢), dollar sign ($), and decimal point (.).	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify all coins and a one-dollar bill, recording the value, using the cent symbol (¢), dollar symbol ($), and decimal point (.).~~ • Determine the value of a collection of coins and one-dollar bills whose total value is $2.00 or less. • Compare the values of two sets of coins and one-dollar bills (each set having a total value of $2.00 or less), using the terms *greater than, less than*, or *equal to*. • Simulate everyday opportunities to count and compare a collection of coins and one-dollar bills whose total value is $2.00 or less. • Use the cent (¢) and dollar ($) symbols and decimal point (.) to write a value of money which is $2.00 or less.

2.11 The student will estimate and measure
a) length to the nearest centimeter and inch;
b) weight/mass of objects in pounds/ounces and kilograms/grams, using a scale; and
c) liquid volume in cups, pints, quarts, gallons, and liters.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A clear concept of the size of one unit ~~(one inch or one centimeter)~~ is necessary before one can measure to the nearest unit. • Knowledge of the exact relationships within the metric or U.S. Customary system of measurement for measuring liquid volume, such as 4 cups to a quart, is not required at this grade level. • Practical experiences measuring liquid volume, using a variety of actual measuring devices (e.g., containers for a cup, pint, quart, gallon, and liter), will help students build a foundation for estimating liquid volume with these measures. • The experience of making a ruler can lead to greater understanding of using one. • Proper placement of a ruler when measuring length (i.e., placing the end of the ruler at one end of the item to be measured) should be demonstrated. • ~~Perimeter is the distance around any two-dimensional shape and is found by adding the measures of the sides.~~ • ~~Linear metric measurement is based on the meter (a base-10 system) and includes centimeters.~~ • ~~Linear standard measurement is based on the foot and includes inches.~~ • ~~A polygon is a simple closed figure lying on a plane, such as a triangle or square. "Simple" means that the lines do not cross.~~ • Weight and mass are different. Mass is the amount	**All students should** • Understand that centimeters/inches are units used to measure length. • Understand how to estimate ~~linear measures and how to use a ruler to~~ and measure to determine a linear measure to the nearest centimeter and inch. • Understand that pounds/ounces and kilograms/grams are units used to measure weight/mass. • Understand how to use a scale to determine the weight/mass of an object and use the appropriate unit for measuring weight/mass. • Understand that cups, pints, quarts, gallons, and liters are units used to measure liquid volume. • Understand how to use measuring devices to determine liquid volume in both metric and customary units. • ~~Understand how to compare measures.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify an inch as a U.S. customary unit for measuring length.~~ • Estimate and measure the length of various line segments and objects to the nearest inch and centimeter. • ~~Identify a centimeter as a metric unit for measuring length.~~ • ~~Estimate and measure the length of various line segments and objects to the nearest centimeter.~~ • ~~Measure each side of a variety of concrete polygons and add them to determine the distance around the polygon (its perimeter).~~ • ~~Determine the distance around a polygon (its perimeter), given the measurements of the sides in centimeters or inches.~~ • ~~Identify pound as the U.S. customary units for measuring weight.~~ • ~~Identify kilogram as a metric unit for measuring mass.~~ • Estimate and then measure the weight/mass of ~~familiar~~ objects to the nearest pounds/ounces and kilograms/grams, using a scale. • ~~Estimate and then measure the weight/mass of familiar objects to the nearest kilogram, using a scale.~~

2.11 The student will estimate and measure

a) length to the nearest centimeter and inch;

b) weight/mass of objects in pounds/ounces and kilograms/grams, using a scale; and

c) liquid volume in cups, pints, quarts, gallons, and liters.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
of matter in an object. Weight is determined by the pull of gravity on the mass of an object. The mass of an object remains the same regardless of its location. The weight of an object changes dependent on the gravitational pull at its location. In everyday life, most people are actually interested in determining an object's mass, although they use the term *weight* (e.g., "How much does it weigh?" versus "What is its mass?"). • ~~Mass is more difficult for young children to understand than length.~~ • A balance is a scale for measuring mass. To determine the mass of an object by using a two-pan balance, first level both sides of the balance by putting standard units of mass on one side to counterbalance the object on the other; then find the sum of the standard units of mass required to level the balance. • Benchmarks of common objects need to be established for one pound and one kilogram ~~(e.g., the mass of a math book is about one kilogram).~~ Practical experience measuring the mass of familiar objects helps to establish benchmarks. • Pounds and kilograms are not compared at this level. • The terms *cups, pints, quarts, gallons*, and *liters* are introduced as terms used to describe the liquid volume of everyday containers. • The exact relationship between a quart and a liter is not expected at this level.		• ~~Identify the metric and U.S. customary units for~~ Estimate and measure ~~measuring~~ liquid volume in ~~(e.g.,~~ cups, pints, quarts, gallons, and liters~~)~~. • ~~Compare customary and metric units of liquid volume (e.g., cups to quarts, liters to quarts), using actual measuring devices and the concepts of *more, less*, and *equivalent*.~~

2.12 The student will tell and write time to the nearest five minutes, using analog and digital clocks.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Telling time requires reading a clock. The position of the two hands on an analog clock is read ~~with the little hand indicating the hour and the long hand indicating the number of minutes after or before an hour~~ to tell the time. A digital clock shows the time by displaying the time in numbers which are read as the hour and minutes. • ~~Time is a unit of measure.~~ • The use of a demonstration clock with gears ensures that the positions of the hour hand and the minute hand are precise at all times. • The face of an analog clock can be divided into 4 equal parts, called *quarter hours*, of 15 minutes each.	**All students should** • Apply an appropriate technique to determine time to the ~~quarter hour~~ nearest five minutes, using analog and digital clocks. • Demonstrate an understanding of counting by fives to predict five minute intervals when telling time to the nearest five minutes.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Show, ~~and~~ tell, and write time to the ~~quarter hour~~ nearest five minutes, using an ~~model~~ analog and digital clock. • ~~Write the time indicated on a digital clock to the nearest quarter hour.~~ • ~~Write the time indicated on an analog clock to the nearest quarter hour.~~ • Match a written time to a time shown on a clock face to the ~~quarter hour~~ nearest five minutes.

2.13 The student will

a) determine past and future days of the week; and

b) identify specific days and dates on a given calendar.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The calendar is a way to represent ~~measure~~ units of time (e.g., days, weeks, and months). • Using a calendar develops the concept of day as a 24-hour period rather than a period of time from sunrise to sunset. • Practical situations are appropriate to develop a sense of the interval of time between events (e.g., Boy Scout meetings occur every week on Monday: there is a week between meetings).	**All students should** • Understand how to use a calendar as a way to measure time.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Read a calendar to locate a given day or date.~~ • ~~Identify the seven days in a week.~~ • Determine the days/dates before and after a given day/date. • Determine the ~~date~~ day that is a specific number of days or weeks in the past or in the future from a given date, using a calendar. • Identify specific days and dates (e.g., the third Monday in a given month or what day of the week does May 11 fall on).

2.14 The student will read the temperature on a Celsius and/or Fahrenheit thermometer to the nearest 10 degrees.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The symbols for degrees in Celsius (°C) and degrees in Fahrenheit (°F) should be used to write temperatures. • Celsius and Fahrenheit temperatures should be related to everyday occurrences by measuring the temperature of the classroom, the outside, liquids, body temperature, and other things found in the environment. • Estimating and measuring temperatures in the environment in Fahrenheit and Celsius require the use of real thermometers. • A physical model can be used to represent the temperature determined by a real thermometer.	**All students should** • Understand how to measure temperature in Celsius and Fahrenheit with a thermometer.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Read temperature to the nearest 10 degrees from real Celsius and Fahrenheit thermometers and from physical models (including pictorial representations) of such thermometers.

Children begin to develop geometric and spatial knowledge before beginning school, stimulated by the exploration of ~~shapes~~ figures and structures in their environment. Geometric ideas help children systematically represent and describe their world as they learn to represent ~~two- and three-dimensional~~ plane and solid ~~shapes~~ figures through drawing, block constructions, dramatization, and verbal language.

The focus of instruction at this level is on

- observing, identifying, describing, comparing, contrasting, and investigating ~~three-dimensional~~ solid objects and their ~~two-dimensional~~ faces;
- sorting objects and ordering them directly by comparing them one to the other;
- describing, comparing, contrasting, sorting, and classifying ~~shapes~~ figures; and
- exploring symmetry, congruence, and transformation.

In the primary grades, children begin to develop basic vocabulary related to these ~~shapes~~ figures but do not develop precise meanings for many of the terms they use until they are thinking beyond Level 2 of the van Hiele theory (see below).

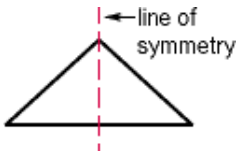
The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.)

2.15 The student will

a) draw a line of symmetry in a figure; and

b) identify and create figures with at least one line of symmetry.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A figure ~~or shape~~ is symmetric along a line when one-half of the figure is the mirror image of the other half. • A line of symmetry divides a symmetrical figure, object, or arrangement of objects into two parts that are congruent if one part is reflected ~~(flipped)~~ over the line of symmetry.  • Children learn about symmetry through hands-on experiences with geometric ~~shapes~~ figures and the creation of geometric pictures and patterns. ~~while playing with shapes.~~ • Guided explorations of the study of symmetry by using mirrors, miras, paper folding, and pattern blocks will enhance students' understanding of the attributes of symmetrical ~~shapes~~ figures. • While investigating symmetry, children move ~~shapes~~ figures, such as pattern blocks, intuitively, thereby exploring transformations of those ~~shapes~~ figures. A transformation is the movement of a figure — either a translation, rotation, or reflection. A translation ~~(slide)~~ is the result of sliding a figure in any direction; rotation ~~(turn)~~ is the result of turning a figure around a point or a vertex; and reflection ~~(flip)~~ is the result of flipping a figure over a line.	**All students should** • Develop strategies to determine whether or not a figure has at least one ~~a~~ line of symmetry. • Develop strategies to create figures with at least one line of symmetry. • Understand that some figures may have more than one line of symmetry.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify ~~and create~~ figures ~~that are symmetrical along a line~~ with at least one line of symmetry, using various concrete materials. • Draw ~~the~~ a line~~(s)~~ of symmetry — horizontal, vertical, and diagonal — in a figure. • ~~Identify and demonstrate a line of symmetry in an object or an arrangement of objects.~~ • ~~Investigate~~ Create figures with at least one line of symmetry using various concrete materials ~~using (e.g., paper folding, mirrors/miras, pattern blocks, wax paper, or tracing paper)~~.

2.16 The student will identify, describe, compare, and contrast plane and solid geometric figures (circle/sphere, square/cube, and rectangle/rectangular prism).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding. – **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons. – **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same (e.g., "I know it's a rectangle because it looks like a door, and I know that a door is a rectangle."). – **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures (e.g., "I know it's a rectangle because it is closed; it has four sides and four right angles, and opposite sides are parallel."). • An important part of geometry is naming and describing ~~shapes~~ figures in two-dimensions (plane ~~shapes~~ figures) and three-dimensions (solid ~~shapes~~ figures). • A vertex is a point where two or more line segments, lines, or rays meet to form an angle. • An angle is two rays that share an endpoint. • Plane figures are two-dimensional figures formed by lines that are curved, straight, or a combination of both. They have angles and edges.	**All students should** • Understand the differences between plane and solid figures while recognizing the inter-relatedness of the two. • Understand that a solid figure is made up of a set of plane figures.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine similarities and differences between related plane and solid ~~shapes~~ figures (e.g., circle/sphere, square/cube, rectangle/rectangular ~~solid~~ prism, using models and cutouts. • Trace faces of solid ~~shapes~~ figures (e.g., cube and rectangular solid) to create the set of plane figures related to the solid ~~shape~~ figure. • Identify and describe plane and solid figures (e.g., circle/sphere, square/cube, and rectangle/rectangular ~~solid~~ prism), according to the number and shape of their faces, edges, and vertices using models. • Compare and contrast plane and solid geometric ~~shapes~~ figures (e.g., circle/sphere, square/cube, and rectangle/rectangular ~~solid~~ prism) according to the number and shape of their faces (sides, bases), edges, vertices, and ~~corners~~ angles.

2.16 The student will identify, describe, compare, and contrast plane and solid geometric figures (circle/sphere, square/cube, and rectangle/rectangular prism).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The identification of ~~two-~~plane and ~~three-dimensional~~ solid figures is accomplished by working with and handling objects. • Tracing faces of solid figures is valuable to understanding the set of plane figures related to the solid figure (e.g., cube and rectangular prism). • A circle is a closed curve in a plane with all its points the same distance from the center. • A sphere is a ~~three-dimensional (~~solid~~)~~ figure with all of its points the same distance from its center. • A square is a rectangle with four sides of equal length. • A rectangular prism is a solid in which all six faces are rectangles. A rectangular prism has 8 vertices and 12 edges. • A cube is a ~~three-dimensional (~~solid~~)~~ figure with six congruent, square faces. All edges are the same length. A cube has 8 vertices and 12 edges. It is a rectangular prism. • A rectangle is a plane figure with four right angles. A square is a rectangle. • ~~A square pyramid is a three-dimensional (solid) figure that has a square base and whose other faces are triangles that share a common vertex.~~ • ~~A cylinder is a three-dimensional (solid) figure with two congruent, parallel circular surfaces joined by a curved surface.~~ • ~~A cone is a three-dimensional (solid), pointed figure that has a flat, round base (usually a circle) that is joined to a vertex by a curved surface.~~		

2.16 The student will identify, describe, compare, and contrast plane and solid geometric figures (circle/sphere, square/cube, and rectangle/rectangular prism).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The edge is the line segment where two faces of a ~~three-dimensional~~ solid figure ~~meet~~ intersect. • A face is a polygon that serves as one side of a ~~three-dimensional~~ solid figure (e.g., a square is a face of a cube). • ~~A corner is the point at which three or more edges meet.~~ • A base is a special face of a ~~three-dimensional (~~solid~~)~~ figure. • The relationship between plane and solid geometric figures, such as the square and the cube or the rectangle and the rectangular ~~solid,~~ prism helps build the foundation for future geometric study of faces, edges, angles, and vertices.		

Students in the primary grades have a natural curiosity about their world, which leads to questions about how things fit together or connect. They display their natural need to organize things by sorting and counting objects in a collection according to similarities and differences with respect to given criteria.

The focus of probability instruction at this level is to help students begin to develop an understanding of the concept of chance. They experiment with spinners, two-colored counters, dice, tiles, coins, and other manipulatives to explore the possible outcomes of situations and predict results. They begin to describe the likelihood of events, using the terms *impossible, unlikely, equally likely, more likely,* and *certain.*

The focus of statistics instruction at this level is to help students develop methods of collecting, organizing, describing, displaying, and interpreting data to answer questions they have posed about themselves and their world.

2.17 The student will use data from experiments to construct picture graphs, pictographs, and bar graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The purpose of a graph is to represent data gathered to answer a question. • ~~Picture and bar graphs are created to communicate the data collected.~~ • Picture graphs are graphs that use pictures to show and compare information. ~~A key should be used to indicate what the picture symbol represents (e.g., one picture of a sneaker represents five sneakers in a graph of shoe types).~~ • Pictographs are graphs that use symbols/pictures to show and compare information. A student can be represented as a stick figure in a pictograph. A key should be used to indicate what the picture symbol represents (e.g., one picture of a sneaker represents five sneakers in a graph of shoe types). • Bar graphs are used to compare counts of different categories (categorical data). Using grid paper may ensure~~s~~ more accurate graphs. – A bar graph uses parallel, horizontal or vertical bars to represent counts for several categories. One bar is used for each category, with the length of the bar representing the count for that category. – There is space before, between, and after the bars. – The axis displaying the scale that represents the count for the categories should extend one increment above the greatest recorded piece of data. Second grade students should be collecting data that are recorded in increments of whole numbers, usually multiples of 1, ~~or~~ 2, or 5. – Each axis should be labeled, and the graph should be given a title.	**All students should** • Understand that data may be generated from experiments. • Understand how data can be collected and organized in picture graphs, pictographs, ~~or~~ and bar graphs. • Understand that picture graphs use pictures to show and compare data. • Understand that pictographs use a symbol/representation of an object, person, etc. • Understand that bar graphs can be used to compare categorical data.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Organize data from experiments, using lists, tables, objects, pictorial representations, tally marks, and charts, in order to construct a graph. • Read the information presented horizontally and vertically on ~~a simple~~ picture graphs, pictographs, ~~or~~ and bar graphs. • Collect no more than 16 pieces of data to answer a given question. • Represent data from experiments by constructing ~~a simple~~ picture graphs, pictographs, ~~or~~ and bar graphs. • Label the axes on a bar graph, limiting the number of categories (categorical data) to four and the increments to multiples of whole numbers (e.g., multiples of 1, 2, or 5). • Label the axes on a picture graph and pictograph, limiting the number of categories to four and including a key where appropriate. • ~~Interpret information from simple picture and bar graphs by writing at least one statement that covers one or both of the following:~~ ~~– Describe the categories of data and the data as a whole (e.g., the total number of responses).~~ ~~– Identify parts of the data that have special characteristics, including categories with the greatest, the least, or the same.~~ • ~~Select the best interpretation of a graph from a set of possible interpretations of the graph.~~

2.17 The student will use data from experiments to construct picture graphs, pictographs, and bar graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~Statements representing an analysis and interpretation of the characteristics of the data in the graph (e.g., similarities and differences, least and greatest, the categories, and total number of responses) should be written.~~ • ~~When data is displayed in an organized manner, the results of investigations can be described, and the questions posed can be answered.~~		

2.18 The student will use data from experiments to predict outcomes when the experiment is repeated.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A spirit of investigation and experimentation should permeate probability instruction, where students are actively engaged in investigations and have opportunities to use manipulatives. • Investigation of experimental probability is continued through informal activities, such as dropping a two-colored counter (usually a chip that has a different color on each side), using a multicolored spinner (a circular spinner that is divided equally into two, three, four or more equal "pie" parts where each part is filled with a different color), using spinners with numbers, or rolling random number generators (dice). • Probability is the chance of an event occurring (e.g., the probability of landing on a particular color when flipping a two-colored chip is $\frac{1}{2}$, representing one of two possible outcomes). • An event is a possible outcome in probability. Simple events include the possible outcomes when tossing a coin (heads or tails), when rolling a random number generator (a number cube or a die where there are six equally likely outcomes and the probability of one outcome is $\frac{1}{6}$), or when spinning a spinner. • If all the outcomes of an event are equally likely to occur, the probability of an event is equal to the number of favorable outcomes divided by the total number of possible outcomes: the probability of the event = $\frac{\text{number of favorable outcomes}}{\text{total number of possible outcomes}}$.	**All students should** • Understand that data may be generated from experiments. • ~~Understand and apply basic concepts of probability.~~ • Understand that the likelihood of an event occurring is to ~~determine~~ predict the probability of it happening.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Conduct probability experiments, using multicolored spinners, colored tiles, or number cubes and use the data from the experiments to predict outcomes if the experiment is repeated. • Record the results of probability experiments, using tables, charts, and tally marks. • Interpret the results of probability experiments (e.g., the two-colored spinner landed on red 5 out of 10 times). • Predict which of two events is more likely to occur if an experiment is repeated.

2.18 The student will use data from experiments to predict outcomes when the experiment is repeated.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• At this level, students need to understand only this fractional representation of probability (e.g., the probability of getting heads when flipping a coin is $\frac{1}{2}$). • Students should have opportunities to describe in informal terms (i.e., *impossible*, *unlikely*, *as likely as*, ~~*unlikely*~~, *equally likely*, *likely*, and *certain*) the degree of likelihood of an event occurring. Activities should include practical examples.		

2.19 The student will analyze data displayed in picture graphs, pictographs, and bar graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Statements that represent an analysis and interpretation of the characteristics of the data in the graph (e.g., similarities and differences, least and greatest, the categories, and total number of responses) should be discussed with students and written. • When data ~~is~~ are displayed in an organized manner, the results of investigations can be described, and the questions posed can be answered.	**All students should** • Understand how to read the key used in a graph to assist in the analysis of the displayed data. • Understand how to interpret data in order to analyze it. • Understand how to analyze data in order to answer the questions posed, make predictions, and generalizations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Interpret~~ Analyze information from simple picture graphs, pictographs, and bar graphs by writing at least one statement that covers one or both of the following: – Describe the categories of data and the data as a whole (e.g., the total number of responses). – Identify parts of the data that have special characteristics, including categories with the greatest, the least, or the same. • Select the best analysis of a graph from a set of possible analyses of the graph.

Stimulated by the exploration of their environment, children begin to develop concepts related to patterns, functions, and algebra before beginning school. Recognition of patterns and comparisons are important components of children's mathematical development.

Students in kindergarten through third grade develop the foundation for understanding various types of patterns and functional relationships through the following experiences:

- sorting, comparing, and classifying objects in a collection according to a variety of attributes and properties;
- identifying, analyzing, and extending patterns;
- creating repetitive patterns and communicating about these patterns in their own language;
- analyzing simple patterns and making predictions about them;
- recognizing the same pattern in different representations;
- describing how both repeating and growing patterns are generated; and
- repeating predictable sequences in rhymes and extending simple rhythmic patterns.

The focus of instruction at the primary level is to observe, recognize, create, extend, and describe a variety of patterns ~~in the real world~~. These students will experience and recognize visual, kinesthetic, and auditory patterns and develop the language to describe them orally and in writing as a foundation to using symbols. They will use patterns to explore mathematical and geometric relationships and to solve problems, and their observations and discussions of how things change will eventually lead to the notion of functions and ultimately to ~~A~~algebra.

2.20 The student will identify, create, and extend a wide variety of patterns.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Identifying and extending patterns is an important process in mathematical thinking. • Analysis of patterns in the real world (e.g., patterns on a butterfly's wings, patterns on a ladybug's shell) leads to the analysis of mathematical patterns such as number patterns and geometric patterns. • Reproduction of a given pattern in a different manifestation, using symbols and objects, lays the foundation for writing numbers symbolically or algebraically. • The simplest types of patterns are repeating patterns. Opportunities to create, recognize, describe, and extend repeating patterns are essential to the primary school experience. • Growing patterns are more difficult for students to understand than repeating patterns because not only must they determine what comes next, they must also begin the process of generalization. Students need experiences with growing patterns in both arithmetic and geometric formats. • In numeric patterns, students must determine the difference, called the *common difference*, between each succeeding number in order to determine what is added to each previous number to obtain the next number. Create an arithmetic number pattern. Sample numeric patterns include – 6, 9, 12, 15, 18, …(growing pattern); – ~~5, 7, 9, 11, 13~~ 20, 18, 16, 14, … (~~repeating numeric~~ growing pattern); ~~and~~ – 1, 2, 4, 7, 11, 16, … (growing ~~numeric~~ pattern)~~.~~; and – 1, 3, 5, 1, 3, 5, 1, 3, 5… (repeating pattern).	**All students should** • Understand patterns are a way to recognize order and to predict what comes next in an arrangement. • Analyze how both repeating and growing patterns are generated.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify a growing and/or repeating pattern from a given geometric or numeric sequence. • Predict the next number, geometric figure, symbol, picture, or object in a given pattern. • Extend a given pattern, using numbers, geometric figures, symbols, pictures, or objects. • Create a new pattern, using numbers, geometric figures, pictures, symbols, or objects. • Recognize the same pattern in different manifestations.

2.20 The student will identify, create, and extend a wide variety of patterns.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• In geometric patterns, students must often recognize transformations of a figure, particularly rotation or reflection. Rotation ~~(turn)~~ is the result of turning a figure around a point or a vertex, and reflection ~~(flip)~~ is the result of flipping a figure over a line.		

2.21 The student will solve problems by completing numerical sentences involving the basic facts for addition and subtraction. The student will create story problems, using the numerical sentences.

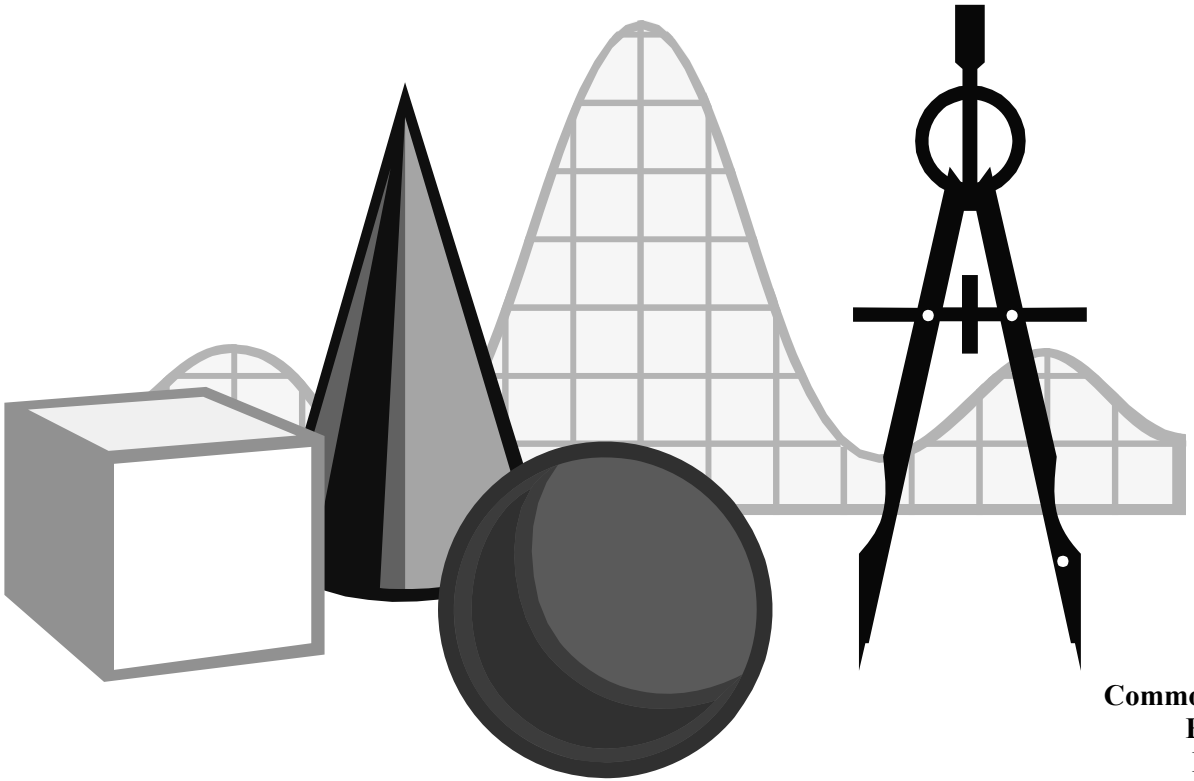
UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Recognizing and using patterns and learning to represent situations mathematically are important aspects of primary mathematics. • Discussing what a word problem is saying and writing a number sentence are precursors to solving word problems. • The patterns formed by related basic facts facilitate the solution of problems involving a missing addend in an addition sentence or a missing part (subtrahend) in a subtraction sentence. • Making mathematical models to represent simple addition and subtraction problems facilitates their solution. • By using story problems and numerical sentences, students begin to explore forming equations and representing quantities using variables. • Students can begin to understand the use of a symbol (e.g., __, ?, or ☐) to represent an unknown quantity.	**All students should** • Use mathematical models to represent and understand quantitative relationships. • Understand various meanings of addition and subtraction and the relationship between the two operations. • Understand how to write missing addend and missing subtrahend sentences.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Solve problems by completing a numerical sentence involving the basic facts for addition and subtraction (e.g., 3 + __ = 7, or 9 – __ = 2). • Create a story problem for a given numerical sentence.

2.22 The student will demonstrate an understanding of equality by recognizing that the symbol = in an equation indicates equivalent quantities and the symbol ≠ indicates that quantities are not equivalent.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The = symbol means that the values on either side are the same (balanced). • The ≠ symbol means that the values on either side are not the same (not balanced). • In order for students to develop the concept of equality, students need to see the = symbol used in various locations (e.g., 3 + 4 = 7 and 5 = 2 + 3). • A number sentence is an equation with numbers (e.g., 6 + 3 = 9; or 6 + 3 = 4 + 5).	**All students should** • Understand that the equal symbol means equivalent (same as) quantities. • The inequality symbol (≠) means not equivalent.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the equality (=) and inequality (≠) symbols. • Identify equivalent values and equations. (e.g., 8 = 8 and 8 = 4 + 4) • Identify nonequivalent values and equations. (e.g., 8 ≠ 9 and 4 + 3 ≠ 8) • Identify and use the appropriate symbol to distinguish between equal and not equal quantities. (e.g., 8 + 2 = 7 + 3 and 1 + 4 ≠ 6 + 2)

MATHEMATICS STANDARDS OF LEARNING CURRICULUM FRAMEWORK

Grade 3



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The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

Students in grades K–3 have a natural curiosity about their world, which leads them to develop a sense of number. Young children are motivated to count everything around them and begin to develop an understanding of the size of numbers (magnitude), multiple ways of thinking about and representing numbers, strategies and words to compare numbers, and an understanding of the effects of simple operations on numbers. Building on their own intuitive mathematical knowledge, they also display a natural need to organize things by sorting, comparing, ordering, and labeling objects in a variety of collections.

Consequently, the focus of instruction in the number and number sense strand is to promote an understanding of counting, classification, whole numbers, place value, ~~simple~~ fractions, number relationships ("more than," "less than," and "~~as many as~~ equal to"), and the effects of ~~simple~~ single-step and multistep computations ~~operations on numbers (fact families)~~. These learning experiences should allow students to engage actively in a variety of problem solving situations and to model numbers (compose and decompose), using a variety of manipulatives. Additionally, students at this level should have opportunities to observe, to develop an understanding of the relationship they see between numbers, and to develop the skills to communicate these relationships in precise, unambiguous terms.

3.1 The student will

a) read and write six-digit numerals and identify the place value and value of each digit;
b) round whole numbers, 9,999 or less, to the nearest ten, hundred, and thousand; and
c) compare two whole numbers between 0 and 9,999, using symbols (>, <, or =) and words (*greater than, less than*, or *equal to*).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The structure of the ~~b~~Base-10 number system is based upon a simple pattern of tens, where each place is ten times the value of the place to its right. This is known as a ten-to-one place value relationship. • The structure of the ~~b~~Base-10 blocks is based on the ten-to-one place value relationship (e.g., 10 ~~cubes~~ units make a long, 10 longs make a flat, 10 flats make a ~~big~~ cube). • Place value refers to the value of each digit and depends upon the position of the digit in the number. In the number 7,864, the eight is in the hundreds place, and the value of the 8 is eight hundred. • Flexibility in thinking about numbers — or "decomposition" of numbers (e.g., 12,345 is 123 hundreds, 4 tens, and 5 ones) — is critical and supports understandings essential to multiplication and division. • Whole numbers may be written in a variety of formats: – Standard: 123,456; – Written: one hundred twenty-three thousand, four hundred fifty-six; and – Expanded: (1 × 100,000) + (2 × 10,000) + (3 × 1,000) + (4 × 100) + (5 × 10) + (6 × 1). • Numbers are arranged into groups of three places called *periods* (ones, thousands, millions, and so on). Places within the periods repeat (hundreds,	**All students should** • Understand that knowledge of place value is essential when comparing numbers. • Understand the relationships in the place value system, where each place is ten times the value of the place to its right. • Understand that rounding gives an estimate to use when exact numbers are not needed for the situation. • Understand the relative magnitude of numbers by comparing numbers.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Investigate and identify the place and value for each digit in a six-digit numeral, using ~~b~~Base-10 manipulatives (e.g., ~~b~~Base-10 blocks). • Use the patterns in the place value system to read and write numbers. • Read six-digit numerals orally. • Write six-digit numerals that are stated verbally or written in words. • Round a given whole number, 9,999 or less, to the nearest ten, hundred, and thousand. • Solve problems, using rounding of numbers, 9,999 or less, to the nearest ten, hundred, and thousand. • Determine which of two whole numbers between 0 and 9,999 is greater. • Determine which of two whole numbers between 0 and 9,999 is less. • Compare two whole numbers between 0 and 9,999, using the symbols >, <, or =. • Use the terms *greater than, less than*, and *equal to* when comparing two whole numbers.

3.1 The student will

a) read and write six-digit numerals and identify the place value and value of each digit;
b) round whole numbers, 9,999 or less, to the nearest ten, hundred, and thousand; and
c) compare two whole numbers between 0 and 9,999, using symbols (>, <, or =) and words (*greater than, less than*, or *equal to*).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
tens, ones). ~~The base-10 blocks of shapes repeat every period (e.g., cube – long – flat, big cube – big long – big flat).~~ Commas are used to separate the periods. Knowing the place value and period of a number helps students find the value of a digit~~s~~ in any number as well as read and write numbers. • To read a whole number through the hundred thousands place, – read the ~~number~~ digits to the first comma; – say the name of the period (e.g., "thousands"); ~~and~~ then – read the last three digits, but do not say the name of the ones period. • Reading and writing large numbers should be related to numbers that have meanings (e.g., numbers found in the students' environment). Concrete materials, such as ~~b~~Base-10 blocks ~~and bundles of sticks,~~ may be used to represent whole numbers through thousands. Larger numbers may be represented ~~by symbol cards~~ on place value charts. • Rounding is one of the estimation strategies ~~and~~ that is often used to assess the reasonableness of a solution or to give ~~a rough idea~~ an estimate of an amount. • Students should explore reasons for estimation, using ~~real-life~~ practical experiences, and use rounding to solve ~~real-life~~ practical situations. • The concept of rounding may be introduced through the use of a number line. When given a number to round, locate it on the number line. Next, determine		

3.1 The student will

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b) round whole numbers, 9,999 or less, to the nearest ten, hundred, and thousand; and
c) compare two whole numbers between 0 and 9,999, using symbols (>, <, or =) and words (*greater than, less than*, or *equal to*).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
the multiple of ten, hundred, or thousand it is between. Then identify to which it is closer. • A procedure for rounding numbers to the nearest ten, hundred, or thousand is as follows: – Look one place to the right of the digit to which you wish to round. – If the digit is less than 5, leave the digit in the rounding place as it is, and change the digits to the right of the rounding place to zero. – If the digit is 5 or greater, add 1 to the digit in the rounding place, and change the digits to the right of the rounding place to zero. • A procedure for comparing two numbers by examining may include the following: – Line up the numbers by place value by lining up the ones. – Beginning at the left, find the first place value where the digits are different. – Compare the digits in this place value to determine which number is greater (or which is less). – Use the appropriate symbol > or < or the words *greater than* or *less than* to compare the numbers in the order in which they are presented. – If both numbers are the same, use the symbol = or the words *equal to*.		

3.2 The student will recognize and use the inverse relationships between addition/subtraction and multiplication/division to complete basic fact sentences. The student will use these relationships to solve problems.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Addition and subtraction are inverse operations, as are multiplication and division~~; that is, one undoes the other~~. • In building thinking strategies for subtraction, an emphasis is placed on connecting the subtraction fact to the related addition fact. The same is true for division, where the division fact is tied to the related multiplication fact. Building fact sentences helps strengthen this relationship. • Addition and subtraction should be taught concurrently in order to develop understanding of the inverse relationship. • Multiplication and division should be taught concurrently in order to develop understanding of the inverse relationship.	**All students should** • Understand how addition and subtraction are related. • Understand how multiplication and division are related.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use the inverse relationships between addition/subtraction and multiplication/division to solve related basic fact sentences. For example, 5 + 3 = 8 and 8 – 3 = __; 4 × 3 = 12 and 12 ÷ 4 = __. • Write three related basic fact sentences when given one basic fact sentence for addition/subtraction and for multiplication/division. For example, given 3 × 2 = 6, ~~write~~ solve the related facts __× 3 = 6, 6 ÷ 3 = __, and 6 ÷ __ = 3.

3.3 The student will

a) name and write fractions (including mixed numbers) represented by a model;
b) model fractions (including mixed numbers) and write the fractions' names; and
c) compare fractions having like and unlike denominators, using words and symbols (>, <, or =).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A fraction is a way of representing part of a whole (as in a region/area model or a length/measurement model) or part of a group (as in a set model). Fractions are used to name a part of one thing or a part of a collection of things. Models can include pattern blocks, fraction bars, rulers, number line, etc. • In each ~~fraction~~ area/region and length/measurement model, the parts must be equal-sized (congruent) ~~(i.e., each pie piece must have the same area; the size of each chip in a set must be equal; the measures such as the red Cuisenaire rod or the connecting cube must be equal)~~. Wholes are ~~broken~~ divided or partitioned into equal-sized parts. ~~and reassembled into wholes.~~ In the set model, each member of the set is an equal part of the set. The members of the set do not have to be equal in size. • The denominator ~~(bottom number)~~ tells how many equal parts are in the whole or set. The numerator ~~(top number)~~ tells how many of those parts are being ~~described~~ considered. • ~~Students should have~~ Provide opportunities to make connections among fraction representations by connecting concrete or pictorial representations with oral language and symbolic representations. • Informal, integrated experiences with fractions at this level will help students develop a foundation for deeper learning at later grades. Understanding the	**All students should** • Understand that the whole must be defined. • Understand that the denominator tells the number of equal parts ~~in~~ that represent a whole. • Understand that the numerator is a counting number that tells how many equal size parts are being considered. • Understand that the value of a fraction is dependent on both the number of parts in a whole (denominator) and the number of those parts being considered (numerator). • Understand that a proper fraction is a fraction whose numerator is smaller than its denominator. • Understand that an improper fraction is a fraction whose numerator is greater than or equal to the denominator and is one or greater than one. • Understand that an improper fraction can be expressed as a whole number or a mixed number. • Understand that a mixed number is written as a whole number and a proper fraction.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Name and write fractions ~~and~~ (including mixed numbers) represented by ~~drawings or concrete materials~~ a model ~~for~~ to include halves, thirds, fourths, eighths, ~~and~~ tenths, and twelfths. • ~~Represent a given fraction or mixed number, and write the fractions' names using~~ Use concrete materials~~,~~ and pictures~~, and symbols~~ to model ~~for~~ at least halves, thirds, fourths, eighths, ~~and~~ tenths, and twelfths. ~~For example, write the symbol for one-fourth, and represent it with concrete materials and pictures.~~ • Compare fractions using the terms greater than, less than, or equal to and the symbols (<, >, and =). Comparisons are made between fractions with both like and unlike denominators, using models, concrete materials and pictures.

3.3 The student will

a) name and write fractions (including mixed numbers) represented by a model;
b) model fractions (including mixed numbers) and write the fractions' names; and
c) compare fractions having like and unlike denominators, using words and symbols (>, <, or =).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
language of fractions (e.g., *thirds* means "three equal parts of a whole," $\frac{1}{3}$ represents one of three equal-size parts when a pizza is shared among three students, or *three-fourths* means "three of four equal parts of a whole") furthers this development. • Comparing unit fractions (a fraction in which the numerator is one) builds a mental image of fractions and the understanding that as the number of pieces of a whole increases, the size of one single piece decreases (e.g., $\frac{1}{5}$ of a bar is smaller than $\frac{1}{4}$ of a bar). • Comparing fractions to a benchmark on a number line (e.g., close to 0, less than $\frac{1}{2}$, exactly $\frac{1}{2}$, greater than $\frac{1}{2}$, or close to 1) facilitates the comparison of fractions when using concrete materials or pictorial models.		

A variety of contexts are necessary for children to develop an understanding of the meanings of the operations such as addition and subtraction. These contexts often arise from real-life experiences in which they are simply joining sets, taking away or separating from a set, or comparing sets. These contexts might include conversations, such as "How many books do we have altogether?" or "How many cookies are left if I eat two?" or "I have three more candies than you do." Although young children first compute using objects and manipulatives, they gradually shift to performing computations mentally or using paper and pencil to record their thinking. Therefore, computation and estimation instruction in the early grades revolves around modeling ~~and~~, discussing, and recording a variety of problem situations. This approach ~~to~~ helps students ~~move~~ transition from the concrete to the representation to the symbolic ~~the abstract~~ ~~and~~ in order to develop meaning for the operations and how they relate to each other.

In grades K–3, computation and estimation instruction focuses on

- relating the mathematical language and symbolism of operations to problem situations;
- understanding different meanings of addition and subtraction of whole numbers and the relation between the two operations;
- developing proficiency with basic addition, subtraction, multiplication, division ~~facts~~ and related facts ~~families~~;
- gaining facility in manipulating whole numbers to add and subtract and in understanding the effects of the operations on whole numbers;
- developing and using strategies and algorithms to solve problems and choosing an appropriate method for the situation;
- choosing, from mental computation, estimation, paper and pencil, and calculators, an appropriate way to compute;
- recognizing whether numerical solutions are reasonable;
- experiencing situations that lead to multiplication and division, such as equal groupings of objects and sharing equally; and
- performing initial operations with fractions ~~and decimals~~.

3.4 The student will estimate solutions to and solve single-step and multistep problems involving the sum or difference of two whole numbers, each 9,999 or less, with or without regrouping.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Addition is the combining of quantities; it uses the following terms: *addend* → 423 *addend* → + 246 *sum* → 669 • Subtraction is the inverse of addition; it yields the difference between two numbers and uses the following terms: *minuend* → 7,698 *subtrahend* → – 5,341 *difference* → 2,357 • An algorithm is a step-by-step method for computing. • An example of an approach to solving problems is Polya's four-step plan: – Understand: Retell the problem; read it twice; take notes; study the charts or diagrams; look up words and symbols that are new. – Plan: Decide what operation(s) and sequence of steps to use to solve the problem. – Solve: Follow the plan and work accurately. If the first attempt does not work, try another plan. – Look back: Does the answer make sense? • Knowing whether to find an exact answer or to make an estimate is learned through practical experiences in recognizing which is appropriate. • When an exact answer is required, opportunities to ~~practice~~ explore ~~recognizing~~ whether the answer can be determined mentally or must involve paper and pencil or calculators help students select the correct	**All students should** • Understand that estimation skills are valuable, time-saving tools particularly in ~~real-life~~ practical situations when exact answers are not required or needed. • Understand that estimation skills are also valuable in determining the reasonableness of the sum or difference when solving for the exact answer is needed. • Develop and use strategies to estimate whole number sums and differences ~~and~~ to ~~judge~~ determine the reasonableness of ~~such estimations~~ an exact answer. • Develop flexible methods of adding whole numbers by combining numbers in a variety of ways, most depending on place values.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine whether an estimate or an exact answer is an appropriate solution for practical addition and subtraction problem~~s~~ situations involving single-step and multistep problems. • Determine whether to add or subtract in practical problem situations. • Estimate the sum or difference of two whole numbers, each 9,999 or less when an exact answer is not required. • Add or subtract two whole numbers, each 9,999 or less. • ~~Estimate and~~ ~~find~~ Solve practical problems involving the sum of two whole numbers, each 9,999 or less, with or without regrouping, using calculators, paper and pencil, or mental computation in practical problem situations. • ~~Estimate and~~ Solve practical problems involving the difference of two whole numbers, each 9,999 or less, with or without regrouping, using calculators, paper and pencil, or mental computation in practical problem situations. • Solve single-step and multistep problems involving the sum or difference of two whole numbers, each 9,999 or less, with or without regrouping.

3.4 The student will estimate solutions to and solve single-step and multistep problems involving the sum or difference of two whole numbers, each 9,999 or less, with or without regrouping.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
approach. • Determining whether an estimate is appropriate and using a variety of strategies to estimate requires experiences with problem situations involving estimation. • There are a variety of mental mathematics strategies for each basic operation, and opportunities to practice these strategies give students the tools to use them at appropriate times. For example, with addition, mental mathematics strategies include – Adding 9: add 10 and subtract 1; and – Making 10: for column addition, look for numbers that group together to make 10. • Using ~~b~~Base-10 materials to model and stimulate discussion about a variety of problem situations helps students understand regrouping and enables them to move from the concrete to the abstract. Regrouping is used in addition and subtraction algorithms. ~~When adding, if the sum in a place is 10 or more, place value is used to regroup the sums so that there is just one digit in each place. When subtracting, if the number in a place is not enough to subtract from, regrouping is required.~~ • Conceptual understanding begins with concrete experiences. Next, the children must make connections that serve as a bridge to the symbolic. One strategy used to make connections is representations, such as drawings, diagrams, tally marks, graphs, or written comments. • ~~A certain amount of practice is necessary to develop fluency with computational strategies for multidigit numbers; however, the practice must be motivating and systematic if students are to develop fluency in~~		

3.4 The student will estimate solutions to and solve single-step and multistep problems involving the sum or difference of two whole numbers, each 9,999 or less, with or without regrouping.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~computation, whether mental, with manipulative materials, or with paper and pencil.~~		

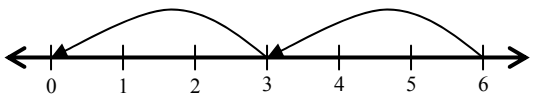
3.5 The student will recall multiplication facts through the twelves table, and the corresponding division facts.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The development of computational fluency relies on quick access to ~~basic~~ number facts. • A certain amount of practice is necessary to develop fluency with computational strategies; however, the practice must be motivating and systematic if students are to develop fluency in computation, whether mental, with manipulative materials, or with paper and pencil. • Strategies to learn the multiplication facts through the ~~nines~~ twelves table include an understanding of multiples/skip counting, properties of zero and one as factors, ~~square numbers~~, pattern of nines, commutative property, and related facts ~~families (the two related multiplication and two division problems)~~. • In order to develop and use strategies to learn the multiplication facts through the ~~nines~~ twelves table, students should use concrete materials, hundred chart, and mental mathematics. • ~~Multiplication is a shortcut for adding same-size groups.~~ To extend the understanding of multiplication, three models may be used: – The equal-sets or equal-groups model lends itself to sorting a variety of concrete objects into equal groups and reinforces repeated addition or skip counting. – The array model, consisting of rows and columns (e.g., 3 rows of 4 columns for a 3-by-4 array) helps build the commutative property. – The length model (e.g., a number line) also reinforces repeated addition or skip counting.	**All students should** • Develop fluency with ~~basic~~ number combinations for multiplication and division. • Understand that multiplication is repeated addition. • Understand that division is the inverse of multiplication. • Understand that patterns and relationships exist in the ~~basic~~ facts. • Understand that number relationships can be used to learn and retain the ~~basic~~ facts.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recall and state the multiplication and division facts through the ~~nines~~ twelves table. • Recall and write the multiplication and division facts through the ~~nines~~ twelves table.

3.6 The student will represent multiplication and division, using area, set, and number line models, and create and solve problems that involve multiplication of two whole numbers, one factor 99 or less and the second factor 5 or less.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The multiplication and division facts through the ~~nines~~ twelves tables should be modeled. • Multiplication is a shortcut for repeated addition. The terms associated with multiplication are listed below: *factor* → 54 *factor* → × 3 *product* → 162 • Creating real-life problems and solving them facilitates the connection between mathematics and everyday experiences (e.g., area problems). • The use of ~~b~~Base-10 blocks and repeated addition can serve as a model. For example, ~~17 × 4~~ 4 × 12 is read as four sets consisting of one rod and ~~seven~~ two units. The sum is renamed as ~~six~~ four rods and eight units or ~~68~~ 48. This can be thought of as ~~(10 + 7) × 4 = (10 × 4) + (7 × 4)~~ ~~40 + 28 = 40 + (20 + 8)~~ ~~(40 + 20) + 8 = 68. (SET)~~ 12 + 12 + 12 + 12 = (SET) • The use of ~~b~~Base-10 blocks and the array model can be used to solve the same problem. A rectangle array that is one rod and ~~seven~~ two units long by four units wide is formed. The area of this array is represented by 4 ~~longs~~ rods and ~~2~~8 units. ~~and can be thought of as~~ ~~(10 + 7) × 4 = (10 × 4) + (7 × 4)~~ ~~40 + 28 = 40 + (20 + 8)~~ ~~(40 + 20) + 8 = 68.~~ ~~(AREA)~~ • The number line model can be used to solve a	**All students should** • Understand ~~various~~ the meanings of multiplication and division. • Understand the ~~effects~~ models used to represent ~~of~~ multiplying and dividing whole numbers.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Model multiplication, using area, ~~and~~ set, and number line models. • Model division, using area, ~~and~~ set, and number line models. • Solve multiplication problems, using the ~~standard~~ multiplication algorithm, where one factor is 99 or less and the second factor is 5 or less. • Create and solve word problems involving multiplication, where one factor is 99 or less and the second factor is 5 or less.

3.6 The student will represent multiplication and division, using area, set, and number line models, and create and solve problems that involve multiplication of two whole numbers, one factor 99 or less and the second factor 5 or less.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
multiplication problem such as 3 × 4. This is represented on the number line by three jumps of four. • The number line model can be used to solve a division problem such as 6 ÷ 3 and is represented on the number line by noting how many jumps of three go from 6 to 0.  The number of jumps (two) of a given length (three) is the answer to the question. • An algorithm is a step-by-step method for computing.		

3.7 The student will add and subtract proper fractions having like denominators of 12 or less.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A proper fraction is a fraction whose numerator is ~~smaller~~ less than ~~its~~ the denominator. A proper fraction is ~~another name for~~ a fraction ~~between zero and~~ that is always less than one. • An improper fraction is a fraction whose numerator is greater than or equal to the denominator. An improper fraction is a fraction that is equal to or greater than one. • An improper fraction can be expressed as a mixed number. A mixed number is written as a whole number and a proper fraction. • The ~~concepts~~ strategies of addition and subtraction applied to fractions are the same as ~~these concepts~~ the strategies applied to whole numbers. • Reasonable answers to problems involving addition and subtraction of fractions can be established by using benchmarks such as 0, $\frac{1}{2}$, and 1. For example, $\frac{3}{5}$ and $\frac{4}{5}$ are each greater than $\frac{1}{2}$, so their sum is greater than 1. • Concrete materials and pictorial models representing area/regions (circles, squares, and rectangles), length/measurements (fraction bars and strips), and sets (counters) can be used to add and subtract fractions having like denominators of ~~10~~ 12 or less.	**All students should** • Understand that a proper fraction is a fraction whose numerator is smaller than its denominator. • Understand that an improper fraction is a fraction whose numerator is greater than or equal to the denominator and is one or greater than one. • Understand that an improper fraction can be expressed as a whole number or a mixed number. • Understand that a mixed number is written as a whole number and a proper fraction. A mixed number is the sum of a whole number and the proper fraction. • Understand that computation with fractions uses the same ~~concepts~~ strategies as whole number computation.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Demonstrate a fractional part ~~(halves, thirds, fourths, eighths, and tenths)~~ of a whole, using – region/area models (e.g., pie pieces, pattern blocks, geoboards, drawings); – set models (e.g., chips, counters, cubes, drawings); and – length/measurement models (e.g., nonstandard units such as ~~cuisenaire~~ rods, connecting cubes, and drawings). • Name and write fractions and mixed numbers represented by drawings or concrete materials ~~for halves, thirds, fourths, eighths, and tenths~~. • Represent a given fraction or mixed number, using concrete materials, pictures, and symbols~~, for halves, thirds, fourths, eighths, and tenths~~. For example, write the symbol for one-fourth and represent it with concrete materials and/or pictures. • Add and subtract with proper fractions having denominators of ~~10~~ 12 or less, using concrete materials and pictorial models representing area/regions (circles, squares, and rectangles), length/measurements (fraction bars and strips), and sets (counters).

Measurement is important because it helps to quantify the world around us and is useful in so many aspects of everyday life. Students in grades K–3 should encounter measurement in many normal situations, from their daily use of the calendar and from science activities that often require students to measure objects or compare them directly, to situations in stories they are reading and to descriptions of how quickly they are growing.

Measurement instruction at the primary level focuses on developing the skills and tools needed to measure length, weight/mass, capacity, time, temperature, area, perimeter, volume, and money. Measurement at this level lends itself especially well to the use of concrete materials. Children can see the usefulness of measurement if classroom experiences focus on estimating and measuring real objects. They gain deep understanding of the concepts of measurement when handling the materials, making physical comparisons, and measuring with tools.

As students develop a sense of the attributes of measurement and the concept of a measurement unit, they also begin to recognize the differences between using nonstandard and standard units of measure. Learning should give them opportunities to apply both techniques and nonstandard and standard tools to find measurements and to develop an understanding of the use of simple U.S. Customary and metric units.

Teaching measurement offers the challenge to involve students actively and physically in learning and is an opportunity to tie together other aspects of the mathematical curriculum, such as fractions and geometry. It is also one of the major vehicles by which mathematics can make connections with other content areas, such as science, health, and physical education.

3.8 The student will determine, by counting, the value of a collection of bills and coins whose total value is $5.00 or less, compare the value of the bills and coins, and make change.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The value of a collection of coins and bills can be determined by counting on, beginning with the highest value, and/or by grouping the coins and bills. • A variety of skills can be used to determine the change after a purchase, including – counting on, using coins and bills, i.e., starting with the amount to be paid (purchase price), counting forward to the next dollar, and then counting forward by dollar bills to reach the amount from which to make change; and – mentally calculating the difference.	**All students should** • Understand that a collection of coins and bills has a value that can be counted. • Understand how to make change from $5.00 or less.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Count the value of collections of coins and bills up to $5.00. • Compare the values of two sets of coins or bills, up to $5.00, using the terms *greater than, less than*, and *equal to*. • Make change from $5.00 or less.

3.9 The student will estimate and use U.S. Customary and metric units to measure

a) length to the nearest $\frac{1}{2}$ inch, inch, foot, yard, centimeter, and meter;

b) liquid volume in cups, pints, quarts, gallons, and liters;

c) weight/mass in ounces, pounds, grams, and kilograms; and

d) area and perimeter.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Weight and mass are different. Mass is the amount of matter in an object. Weight is determined by the pull of gravity on the mass of an object. The mass of an object remains the same regardless of its location. The weight of an object changes dependent on the gravitational pull at its location. In everyday life, most people are actually interested in determining an object's mass, although they use the term *weight* (e.g., "How much does it weigh?" versus "What is its mass?"). • The concept of a standard measurement unit is one of the major ideas in understanding measurement. Familiarity with standard units is developed through hands-on experiences of comparing, estimating, measuring, and constructing. • Benchmarks of common objects need to be established for each of the specified units of measure (e.g., the mass of a mathematics book is about one kilogram). Practical experience measuring the mass of familiar objects helps to establish benchmarks and facilitates the student's ability to estimate measures. • One unit of measure may be more appropriate than another to measure an object, depending on the size of the object and the degree of accuracy desired. • Correct use of measurement tools is essential to understanding the concepts of measurement. • Perimeter is the distance around any two-dimensional	**All students should** • Understand how to estimate measures of length, liquid volume, ~~and~~ weight/mass, area and perimeter. • Understand how to determine the actual measure of length, liquid volume, ~~and~~ weight/mass, area and perimeter. • Understand that perimeter is a measure of the distance around a polygon. • Understand that area is a measure of square units needed to cover a surface.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify and use the following units of length: centimeters, meters, part of an inch, inches, feet, and yards, centimeters, and meters.~~ • ~~Identify and use the following units of liquid volume: cups, pints, quarts, gallons, and liters.~~ • ~~Identify and use the following units of weight/mass: ounces, pounds, grams, and kilograms.~~ • Estimate and ~~then measure~~ use U.S. Customary and metric units to measure lengths of objects to the nearest ~~centimeter, and meter, and the nearest~~ $\frac{1}{2}$ of an inch, inch, foot, ~~and~~ yard, centimeter, and meter. • ~~Estimate and then measure lengths of~~ Determine the actual measure of length using U.S. Customary and metric units to measure objects to the nearest ~~centimeter and meter, and the nearest~~ $\frac{1}{2}$ of an inch, foot, ~~and~~ yard, centimeter, and meter. • Estimate and ~~then measure~~ use U.S. Customary and metric units to measure the weight/mass of

3.9 The student will estimate and use U.S. Customary and metric units to measure

a) length to the nearest $\frac{1}{2}$ inch, inch, foot, yard, centimeter, and meter;

b) liquid volume in cups, pints, quarts, gallons, and liters;

c) weight/mass in ounces, pounds, grams, and kilograms; and

d) area and perimeter.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~shape~~ figure and is found by adding the measures of the sides. • Area is a two-dimensional measure and is therefore measured in square units. • Area is the number of square units needed to cover a figure, or more precisely, it is the measure in square units of the interior region of a two-dimensional figure.		objects to the nearest ounce, ~~and~~ pound, ~~and the nearest~~ gram, and kilogram. • Determine the actual measure of weight/mass using U.S. Customary and metric units to measure the weight/mass of objects to the nearest ounce, ~~and~~ pound, ~~and the nearest~~ gram, and kilogram. • Estimate and ~~then measure~~ use U.S. Customary and metric units to measure liquid volume to the nearest cup, pint, quart, gallon, and liter. • Determine the actual measure of liquid volume using U.S. Customary and metric units to measure to the nearest cup, pint, quart, gallon, and liter. • Estimate and use U.S. Customary and metric units to measure area and perimeter. • Determine the actual measure of area or perimeter using U.S. Customary and metric units.

3.10 The student will

a) measure the distance around a polygon in order to determine perimeter; and

b) count the number of square units needed to cover a given surface in order to determine area.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A polygon is a closed plane figure composed of at least three line segments that do not cross. None of the sides are curved. • Perimeter is a measure of the distance around a polygon and is found by adding the measures of the sides. • ~~Area is a measure of square units needed to cover a surface. Area may be determined by counting the number of square units on a given surface.~~ Area is the number of iterations of a two-dimensional unit needed to cover a surface. The two-dimensional unit is usually a square, but it could also be another shape such as a rectangle or an equilateral triangle. • Opportunities to explore the concepts of perimeter and area should involve hands-on experiences (e.g., placing tiles (units) around a polygon and counting the number of tiles to determine its perimeter and filling or covering a polygon with cubes (square units) and counting the cubes to determine its area).	**All students should** • Understand the meaning of a polygon as a closed figure with at least three sides. None of the sides are curved and there are no intersecting lines. • Understand that perimeter is a measure of the distance around a polygon. • Understand how to determine the perimeter by counting the number of units around a polygon. • Understand that area is a measure of square units needed to cover a surface. • Understand how to determine the area by counting the number of square units.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Measure each side of a variety of ~~concrete~~ polygons and add ~~them~~ the measures of the sides to determine the ~~distance around~~ perimeter of ~~the~~ each polygon ~~(its perimeter)~~. • Determine the area of a given surface ~~on grid paper~~ by estimating and then counting the number of square units needed to cover the surface.

3.11 The student will

a) tell time to the nearest minute, using analog and digital clocks; and

b) determine elapsed time in one-hour increments over a 12-hour period.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Telling time is applying reading skills to a clock face.~~ • While digital clocks make reading time easy, it is necessary to ensure that students understand that there are sixty minutes in an hour. • Use of a demonstration clock with gears ensures that the positions of the hour hand and the minute hand are precise when time is read. • Students need to understand that time has passed or will pass. • Elapsed time is the amount of time that has passed between two given times. • ~~Use of a~~ Elapsed time should be modeled and ~~demonstration~~ demonstrated using geared analog clocks ~~with gears ensures that the positions of the hour hand and the minute hand are precise when time is read~~ and timelines. • ~~While digital clocks make reading time easy, i~~ It is necessary to ensure that students understand that there are sixty minutes in an hour when using analog and digital clocks. • Elapsed time can be found by counting on from the beginning time to the finishing time. – Count the number of whole hours between the beginning time and the finishing time. For example, to find the elapsed time between 7 a.m. and 10 a.m., students can count on to find the difference between the times (7 and 10), so the total elapsed time is 3 hours.	**All students should** • Apply appropriate techniques to determine time to the nearest ~~five-minute interval~~ minute, using analog and digital clocks. • Understand how to determine elapsed time in one-hour increments over a 12-hour period.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Tell time to the ~~hour, half hour, quarter hour, nearest five-minute interval, and~~ nearest minute, using analog and digital clocks. • Match the times shown on analog and digital clocks to written times and to each other. • When given the beginning time and ending time, determine the elapsed time in one-hour increments~~.~~ ~~Determine the elapsed time in one-hour increments~~ within a 12-hour period (times do not cross between a.m. and p.m.). • Solve practical problems in relation to time that has elapsed.

3.12 The student will identify equivalent periods of time, including relationships among days, months, and years, as well as minutes and hours.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The knowledge that a year has $365\frac{1}{4}$ days will help students understand the necessity of adding a full day every fourth year, called a *leap year*. • The use of a calendar facilitates the understanding of time relationships between days and months, days and weeks, days and years, and months and years. Recognize that students need to know the relationships, such as if there are 24 hours in one day, how many hours are in three days? If the date is January 6, what date would it be in two weeks? How many weeks are in March, April, and May? • The use of an analog clock facilitates the understanding of time relationships between minutes and hours and hours and days.	**All students should** • Understand the relationship that exists among periods of time, using calendars, and clocks.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify equivalent relationships observed in a calendar, including the number of days in a given month, the number of days in a week, the number of days in a year, and the number of months in a year. • Identify the number of minutes in an hour and the number of hours in a day.

3.13 The student will read temperature to the nearest degree from a Celsius thermometer and a Fahrenheit thermometer. Real thermometers and physical models of thermometers will be used.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Estimating and measuring temperatures in the environment in Fahrenheit and Celsius require the use of real thermometers. • A physical model can be used to represent the temperature determined by a real thermometer. • The symbols for degrees in Celsius (°C) and degrees in Fahrenheit (°F) should be used to write temperatures. • Celsius and Fahrenheit temperatures should be related to everyday occurrences by measuring the temperature of the classroom, the outside, liquids, body temperature, and other things found in the environment.	**All students should** • Understand how to measure temperature in Celsius and Fahrenheit with a thermometer.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Read temperature to the nearest degree from real Celsius and Fahrenheit thermometers and from physical models (including pictorial representations) of such thermometers.

Children begin to develop geometric and spatial knowledge before beginning school, stimulated by the exploration of ~~shapes~~ figures and structures in their environment. Geometric ideas help children systematically represent and describe their world as they learn to represent ~~two- and three-dimensional~~ plane and solid ~~shapes~~ figures through drawing, block constructions, dramatization, and verbal language.

The focus of instruction at this level is on

- observing, identifying, describing, comparing, contrasting and investigating ~~three-dimensional~~ solid objects and their ~~two-dimensional~~ faces;
- sorting objects and ordering them directly by comparing them one to the other;
- describing, comparing, contrasting, sorting, and classifying ~~shapes~~ figures; and
- exploring symmetry, congruence, and transformation.

In the primary grades, children begin to develop basic vocabulary related to these ~~shapes~~ figures but do not develop precise meanings for many of the terms they use until they are thinking beyond Level 2 of the van Hiele theory (see below).

The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.)

3.14 The student will identify, describe, compare, and contrast characteristics of plane and solid geometric figures (circle, square, rectangle, triangle, cube, rectangular prism, square pyramid, sphere, cone, and cylinder) by identifying relevant characteristics, including the number of angles, vertices, and edges, and the number and shape of faces, using concrete models.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding. – **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons. – **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same (e.g., "I know it's a rectangle because it looks like a door, and I know that the door is a rectangle."). – **Level 2: Analysis**. Properties are perceived, but are isolated and unrelated. Students should recognize and name properties of geometric figures (e.g., "I know it's a rectangle because it's closed, it has four sides and four right angles, and opposite sides are parallel."). • A plane geometric figure is any two-dimensional closed ~~shape~~ figure. Circles and polygons are examples of plane geometric figures. • Three-dimensional figures are called *solid figures* or simply *solids*. Solids enclose a region of space. The interior of both plane and solid figures are not part of the figure. Solids are classified by the types of surfaces they have. These surfaces may be flat,	**All students should** • Understand how to identify and describe plane and solid geometric figures by using relevant characteristics. • ~~Understand how to describe plane or solid using characteristics more precise ways to describe shapes by focusing on characteristics and the specialized vocabulary associated with these shapes and characteristics.~~ • Understand the similarities and differences between ~~two-dimensional (~~plane~~)~~ and ~~three-dimensional (~~solid~~)~~ figures ~~while recognizing the commonalties of the two~~.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify ~~by name,~~ models~~,~~ and pictures of plane geometric figures (circle, square, rectangle, and triangle) and solid geometric figures (cube, rectangular ~~solid~~ prism, square pyramid, sphere, cone, and cylinder) by name. • Identify and describe plane geometric figures by counting the number of sides, ~~corners, and square corners, and~~ angles, the number and shape of faces, vertices, and edges. • Identify and describe ~~geometric solids~~ solid geometric figures by counting the number of ~~corners, square corners~~ angles, vertices, and edges~~,~~ and by the number and shape~~s~~ of ~~the~~ faces. • C~~lassify, compare~~ Compare and contrast characteristics of plane and solid geometric figures (e.g., circle/sphere, square/cube, triangle/square pyramid, and rectangle/rectangular ~~solid~~ prism), ~~using corners, square corners,~~ by counting the number of sides, angles, vertices, ~~faces, and~~ edges, and the number and shape of faces. • Compare and contrast characteristics of ~~three-dimensional (~~solid~~)~~ ~~shapes~~ geometric figures (i.e., cube, rectangular ~~solid~~ prism, square pyramid, sphere, cylinder, and cone) to similar objects in everyday life (e.g., a party hat is like a cone). • ~~Identify and name cubes, rectangular solids~~

3.14 The student will identify, describe, compare, and contrast characteristics of plane and solid geometric figures (circle, square, rectangle, triangle, cube, rectangular prism, square pyramid, sphere, cone, and cylinder) by identifying relevant characteristics, including the number of angles, vertices, and edges, and the number and shape of faces, using concrete models.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
curved, or both. • The study of geometric figures must be active, using visual images and concrete materials. • Access to a variety of concrete tools such as graph paper, pattern blocks, geoboards, and geometric solids is greatly enhanced by computer software tools that support exploration. • Opportunity must be provided for building and using geometric vocabulary to describe ~~two-dimensional (~~plane~~)~~ and ~~three-dimensional (~~solid~~)~~ ~~shapes~~ figures. • ~~It is appropriate at this level to refer to "square corner." However, teachers should begin to introduce the term *right angle* for square corner as well.~~ • A cube is a ~~three-dimensional~~ solid figure with six congruent square faces and with every edge the same length. A cube has 8 ~~corners~~ vertices and 12 edges. • A cylinder is a ~~three-dimensional~~ solid figure formed by two congruent parallel circles joined by a curved surface. • A cone is a ~~three-dimensional,~~ solid, pointed figure that has a flat, round ~~base~~ face (usually a circle) that is joined to a vertex by a curved surface. • A rectangular ~~solid~~ prism is a ~~three-dimensional~~ solid figure in which all six faces are rectangles with three pair of parallel congruent opposite faces. • A sphere is a ~~three-dimensional~~ solid figure with all of its points the same distance from its center. • A square pyramid is a ~~three-dimensional~~ solid figure		~~(prisms), square pyramids, spheres, cylinders, and cones by their appearance.~~ • ~~Identify and describe cubes, rectangular solids (prisms), square pyramids, spheres, cylinders, and cones according to the number and shape of their faces (sides, bases), edges, and corners and the number of angles and vertices.~~ • Identify ~~properties~~ characteristics of ~~three-dimensional (~~solid~~)~~ geometric ~~shapes~~ figures (cylinder, cone, cube, square pyramid, and rectangular prism). • ~~Analyze and compare properties of three-dimensional (solid) geometric shapes (cylinder, cone, cube, square pyramid, and rectangular prism).~~

3.14 The student will identify, describe, compare, and contrast characteristics of plane and solid geometric figures (circle, square, rectangle, triangle, cube, rectangular prism, square pyramid, sphere, cone, and cylinder) by identifying relevant characteristics, including the number of angles, vertices, and edges, and the number and shape of faces, using concrete models.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~whose base is a~~ with one square face and ~~whose other faces are triangles~~ four triangular faces that share a common vertex. • A face is a polygon that serves as one side of a ~~three-dimensional~~ solid figure (e.g., a square is a face of a cube). • An angle is formed by two rays h~~aving~~ with a common endpoint. This endpoint is called the *vertex*. Angles are found wherever lines ~~and line segments~~ intersect. An angle can be named in three different ways by using – three letters to name, in this order, a point on one ray, the vertex, and a point on the other ray; – one letter at the vertex; or – a number written inside the rays of the angle. • An edge is the line segment where two faces of a ~~three-dimensional~~ solid figure ~~meet~~ intersect. • ~~A corner is the point at which three or more edges meet.~~ A vertex is the point at which two lines, line segments, or rays meet to form an angle. It is also the point on a three dimensional figure where three or more faces intersect. • Students should be reminded that a ~~concrete three-dimensional~~ solid geometric object~~, even when called a "solid," may actually be~~ is hollow rather than solid. The "solid" indicates a three-dimensional figure.		

3.15 The student will identify and draw representations of points, line segments, rays, angles, and lines.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A point is an exact location in space. It has no length or width. Usually, a point is named with a capital letter. • A line is a collection of points going on and on in both directions. It has no endpoints. When a line is drawn, at least two points on it can be marked and given capital letter names. The line can also be named with a single, lower-case letter. Arrow~~head~~s must be drawn to show that the line goes on in both directions infinitely. • A line segment is part of a line. It has two endpoints and includes all the points between those endpoints. The endpoints are used to name a line segment. • A ray is part of a line. It has one endpoint and continues on and on in one direction. • An angle is formed by two rays having a common endpoint. This endpoint is called the *vertex*. Angles are found wherever lines and line segments intersect. An angle can be named in three different ways by using – three letters to name, in this order, a point on one ray, the vertex, and a point on the other ray; – one letter at the vertex; or – a number written inside the rays of the angle. • Angle rulers may be particularly useful in developing the concept of an angle.	**All students should** • Understand that line segments and angles are fundamental components of ~~noncircular,~~ plane polygons. • Understand that a line segment is a part of a line, ~~having~~ has two end points, and ~~that it~~ contains all the points between those two endpoints. • Understand that points make up a line. • Understand that a line continues indefinitely in two opposite directions. • Understand that a ray is part of a line, ~~with~~ has one endpoint, and continues indefinitely in only one direction. • Understand that an angle is formed by two rays having a common endpoint.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify ~~and locate~~ examples of ~~a~~ points, line segments, rays, ~~and~~ angles, and lines. • Draw representations of points, line segments, rays, ~~and~~ angles, and lines, using a ruler or straightedge.

3.16 The student will identify and describe congruent and noncongruent plane figures.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Congruent plane figures are figures having exactly the same size and shape. Noncongruent plane figures are figures that are not exactly the same size and shape. Opportunities for exploring figures that are congruent and/or noncongruent can best be accomplished by using physical models. • ~~A figure or shape is symmetrical when one-half of the figure is the mirror image of the other half. Opportunities for exploring symmetry in figures can best be accomplished by using physical models.~~ • ~~A line of symmetry divides a symmetrical figure, object, or arrangement of objects into two parts that are congruent if one part is reflected (flipped) over the line of symmetry.~~ • ~~While investigating symmetry, students move shapes, such as pattern blocks, intuitively, thereby exploring transformations of those shapes. A transformation is the movement of a figure — either a translation, rotation, or reflection. A translation (slide) is the result of sliding a figure in any direction; a rotation (turn) is the result of turning a figure around a point or a vertex; and a reflection (flip) is the result of flipping a figure over a line.~~ • Have students identify figures that are congruent or noncongruent by using direct comparisons and/or tracing procedures.	**All students should** • Understand that congruent ~~shapes~~ plane figures match exactly. • Understand that noncongruent plane figures do not match exactly. • Understand that congruent plane figures remain congruent even if they are in different spatial orientations. • Understand that noncongruent plane figures remain noncongruent even if they are in different spatial orientations. • ~~Understand that symmetrical figures can be divided into two halves that are the mirror image of each other.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Locate examples of symmetrical figures, and verify their symmetry by using tracing procedures.~~ • ~~Determine if given figures have a line or lines of symmetry (vertical, horizontal, diagonal), using tracing procedures.~~ • ~~Locate~~ Identify examples of congruent and noncongruent figures. ~~and verify~~ Verify their congruenc~~y~~e by laying one on top of the other using drawings or models. • Determine ~~if given~~ and explain why plane figures are congruent ~~and~~ or noncongruent, using tracing procedures.

Students in the primary grades have a natural curiosity about their world, which leads to questions about how things fit together or connect. They display their natural need to organize things by sorting and counting objects in a collection according to similarities and differences with respect to given criteria.

The focus of probability instruction at this level is to help students begin to develop an understanding of the concept of chance. They experiment with spinners, two-colored counters, dice, tiles, coins, and other manipulatives to explore the possible outcomes of situations and predict results. They begin to describe the likelihood of events, using the terms *impossible, unlikely, equally likely, more likely,* and *certain.*

The focus of statistics instruction at this level is to help students develop methods of collecting, organizing, describing, displaying, and interpreting data to answer questions they have posed about themselves and their world.

3.17 The student will

a) collect and organize data, using observations, measurements, surveys, or experiments;
b) construct a line plot, a picture graph, or a bar graph to represent the data; and
c) read and interpret the data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Investigations involving data should occur frequently and relate to students' experiences, interests, and environment. • Formulating questions for investigations is student-generated at this level. For example: What is the ~~favorite~~ cafeteria lunch preferred by students in the class when four lunch menus are offered? • The purpose of a graph is to represent data gathered to answer a question. • Bar graphs are used to compare counts of different categories (categorical data). Using grid paper ensures more accurate graphs. – A bar graph uses parallel, horizontal or vertical bars to represent counts for ~~several~~ categories. One bar is used for each category, with the length of the bar representing the count for that category. – There is space before, between, and after the bars. – The axis displaying the scale representing the count for the categories should extend one increment above the greatest recorded piece of data. Third grade students should collect data that are recorded in increments of whole numbers, usually multiples of 1, 2, 5, or 10. – Each axis should be labeled, and the graph should be given a title. – Statements representing an analysis and interpretation of the characteristics of the data in the graph (e.g., similarities and differences,	**All students should** • Understand how ~~gathered~~ data can be collected and organized. • Understand that data can be displayed in different types of graphs depending on the ~~questions to be answered~~ data. • Understand how to construct a line plot, picture graph, or bar graph. • Understand that data sets can be interpreted and analyzed to ~~provide different kinds of information~~ draw conclusions.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Formulate questions to investigate. • Design data investigations to answer formulated questions, limiting the number of categories for data collection to four. • Collect data, using surveys, polls, questionnaires, scientific experiments, and observations. • Organize data and construct a bar graph on grid paper representing 16 or fewer data points for no more than four categories. • Label bar graphs with a title, a description of each axis, and a key where appropriate. Limit increments on the numerical axis to whole numbers representing multiples of 1, 2, 5, or 10. • Read the information presented on a simple bar or picture graph (e.g., the title, the categories, the description of the two axes, the key). • Analyze and interpret information from picture and bar graphs, with up to 30 data points and up to 8 categories, by writing at least one sentence. • Construct a line plot with no more than 30 data points. • ~~Read information presented in line plots.~~ • ~~Analyze and interpret~~ Read, interpret and analyze

3.17 The student will

a) collect and organize data, using observations, measurements, surveys, or experiments;
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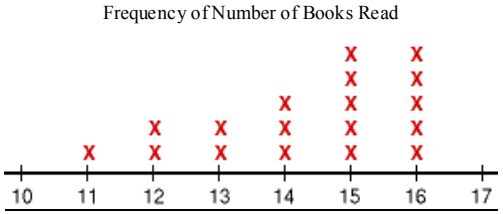
c) read and interpret the data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
least and greatest, the categories, and total number of responses) should be written. • ~~Line plots show the spread of data. To construct a line plot,~~ ~~– draw a number line on grid paper (The scale of numbers should include the greatest value and the least value in a set of numbers.);~~ ~~– for each piece of data, draw an *x* above the corresponding number; and~~ ~~– title the plot.~~ • A line plot shows the frequency of data on a number line. Line plots are used to show the spread of the data and quickly identify the range, mode, and any outliers.  • When data are displayed in an organized manner, the results of the investigations can be described and the posed question answered. • Recognition of appropriate and inappropriate statements begins at this level with graph interpretations.		information from line plots~~, with data points limited to 16,~~ by writing at least one statement. • Describe the categories of data and the data as a whole (e.g., data were collected on four ~~types~~ ways to cook or prepare ~~of~~ eggs — scrambled, fried, hard boiled, and egg salad — eaten by students). • Identify parts of the data that have special characteristics, including categories with the greatest, the least, or the same (e.g., most students prefer scrambled eggs). • Select a correct interpretation of a graph from a set of interpretations of the graph, where one is correct and the remaining ~~three~~ are incorrect. For example, a bar graph containing data on four ~~types~~ ways to cook or prepare ~~of~~ eggs — eaten by students shows that more students prefer scrambled eggs. A correct answer response, if given, would be that more students prefer scrambled eggs than any other ~~type of eggs~~ way to cook or prepare eggs.

3.18 The student will investigate and describe the concept of probability as chance and list possible results of a given situation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A spirit of investigation and experimentation should permeate probability instruction, where students are actively engaged in explorations and have opportunities to use manipulatives. • Investigation of experimental probability is continued at this level through informal activities using two-colored counters, spinners, and random number generators (number cubes). • Probability is the chance of an event occurring. • The probability of an event occurring is the ratio of desired outcomes to the total number of possible outcomes. If all the outcomes of an event are equally likely to occur, the probability of the event = $\frac{\text{number of favorable outcomes}}{\text{total number of possible outcomes}}$. • The probability of an event occurring is represented by a ratio between 0 and 1. An event is "impossible" if it has a probability of 0 (e.g., the probability that the month of April will have 31 days). An event is "certain" if it has a probability of 1 (e.g., the probability that the sun will rise tomorrow morning). • When a probability experiment has very few trials, the results can be misleading. The more times an experiment is done, the closer the experimental probability comes to the theoretical probability (e.g., a coin lands heads up half of the time). • Students should have opportunities to describe in informal terms (i.e., *impossible*, *unlikely*, *as likely as*, *equally likely*, *likely*, and *certain*) the degree of likelihood of an event occurring. Activities should include real-life examples.	**All students should** • Investigate, ~~U~~understand, and apply basic concepts of probability. • Understand that probability is the chance of an event happening.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Define probability as the chance that an event will happen. • List all possible outcomes for a given situation (e.g., heads and tails are the two possible outcomes of flipping a coin). • ~~Identify the possible outcomes for a common event, using terms such as *impossible*, *unlikely*, *equally likely*, *likely*, and *certain*.~~ • Identify the degree of likelihood of an outcome occurring using terms such as *impossible*, *unlikely*, *as likely as*, *equally likely*, *likely*, and *certain*.

3.18 The student will investigate and describe the concept of probability as chance and list possible results of a given situation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• For any event, such as flipping a coin, the equally likely things that can happen are called *outcomes*. For example, there are two equally likely outcomes when flipping a coin: the coin can land heads up, or the coin can land tails up. • A sample space represents all possible outcomes of an experiment. The sample space may be organized in a list, table, or chart.		

Stimulated by the exploration of their environment, children begin to develop concepts related to patterns, functions, and algebra before beginning school. Recognition of patterns and comparisons are important components of children's mathematical development.

Students in kindergarten through third grade develop the foundation for understanding various types of patterns and functional relationships through the following experiences:

- sorting, comparing, and classifying objects in a collection according to a variety of attributes and properties;
- identifying, analyzing, and extending patterns;
- creating repetitive patterns and communicating about these patterns in their own language;
- analyzing simple patterns and making predictions about them;
- recognizing the same pattern in different representations;
- describing how both repeating and growing patterns are generated; and
- repeating predictable sequences in rhymes and extending simple rhythmic patterns.

The focus of instruction at the primary level is to observe, recognize, create, extend, and describe a variety of patterns ~~in the real world~~. These students will experience and recognize visual, kinesthetic, and auditory patterns and develop the language to describe them orally and in writing as a foundation to using symbols. They will use patterns to explore mathematical and geometric relationships and to solve problems, and their observations and discussions of how things change will eventually lead to the notion of functions and ultimately to ~~A~~algebra.

3.19 The student will recognize and describe a variety of patterns formed using numbers, tables, and pictures, and extend the patterns, using the same or different forms.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Exploring patterns requires active physical and mental involvement. • The use of materials to extend patterns permits experimentation or trial-and-error approaches that are almost impossible without them. • Reproduction of a given pattern in a different representation, using symbols and objects, lays the foundation for writing numbers symbolically or algebraically. • The simplest types of patterns are repeating patterns. In each case, students need to identify the basic unit of the pattern and repeat it. Opportunities to create, recognize, describe, and extend repeating patterns are essential to the primary school experience. • Growing patterns are more difficult for students to understand than repeating patterns because not only must they determine what comes next, they must also begin the process of generalization. Students need experiences with growing patterns in both arithmetic and geometric formats. • Create an arithmetic number pattern. Sample numeric patterns include – 6, 9, 12, 15, 18, …(growing pattern); – 1, 2, 4, 7, 11, 16, …(growing pattern); – 20, 18, 16, 14,… (growing pattern); and – ~~2, 4, 8, 16, 32,~~ 1, 3, 5, 1, 3, 5, 1, 3, 5 … (repeating pattern)~~; and~~. ~~1, 5, 25, 125, 625, ….~~	**All students should** • Understand that numeric and geometric patterns can be expressed in words or symbols. • Understand the structure of a pattern and how it grows or changes. • Understand that mathematical relationships exist in patterns. • Understand that patterns can be translated from one representation to another.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize repeating and growing numeric and geometric patterns (e.g., skip counting, addition tables, and multiplication tables). • Describe repeating and growing numeric and geometric patterns formed using ~~concrete objects~~, numbers, tables, and/or pictures, using the same or different forms. • Extend repeating and growing ~~numeric and geometric~~ patterns of numbers or figures ~~formed~~ using concrete objects, numbers, tables, and/or pictures~~, using the same or different forms~~.

3.19 The student will recognize and describe a variety of patterns formed using numbers, tables, and pictures, and extend the patterns, using the same or different forms.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• In geometric patterns, students must often recognize transformations of a figure, particularly rotation or reflection. Rotation ~~(turn)~~ is the result of turning a figure around a point or a vertex, and reflection ~~(flip)~~ is the result of flipping a figure over a line. • Sample geometric patterns include – O Δ O O Δ Δ O O O Δ Δ Δ …; and – □□ □ □□ □ …. • A table of values can be analyzed to determine the pattern that has been used, and that pattern can then be used to find the next value.		

3.20 The student will

a) investigate the identity and the commutative properties for addition and multiplication; and

b) identify examples of the identity and commutative properties for addition and multiplication.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Investigating arithmetic operations with whole numbers helps students learn about several different properties of arithmetic relationships. These relationships remain true regardless of the numbers. • The commutative property for addition states that changing the order of the addends does not affect the sum (e.g., 4 + 3 = 3 + 4). Similarly, the commutative property for multiplication states that changing the order of the factors does not affect the product (e.g., 2 × 3 = 3 × 2). • The identity property for addition states that if zero is added to a given number, the sum is the same as the given number. The identity property of multiplication states that if a given number is multiplied by one, the product is the same as the given number. • A number sentence is an equation with numbers (e.g., 6 + 3 = 9; or 6 + 3 = 4 + 5).	**All students should** • Understand that mathematical relationships can be expressed using number sentences. • Understand the identity property for addition. • Understand the identity property for multiplication. • Understand the commutative property of addition. • Understand the commutative property of multiplication. • Understand that quantities on both sides of an equal~~s~~ sign must be equal. • Understand that quantities on both sides of the not equal sign are not equal ~~and are not balanced~~ .	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Investigate the identity property for addition and determine that when the number zero is added to another number or another number is added to the number zero, that number remains unchanged. Examples of the identity property for addition are 0 + 2 = 2; 5 + 0 = 5. • Investigate the identity property for multiplication and determine that when the number one is multiplied by another number or another number is multiplied by the number one, that number remains unchanged. Examples of the identity property for multiplication are 1 x 3 = 3; 6 x 1 = 6. • Recognize ~~T~~that the commutative property for addition is an order property. Changing the order of the addends does not change the sum (5 + 4 = 9 and 4 + 5 = 9). • Recognize ~~T~~that the commutative property for multiplication is an order property. Changing the order of the factors does not change the product (2 × 3 = 3 × 2) . ~~• Recognize that the equals sign (=) relates equivalent quantities.~~ ~~• Recognize that the not equal sign (≠) relates nonequivalent quantities.~~ • Write number sentences to represent equivalent

3.20 The student will

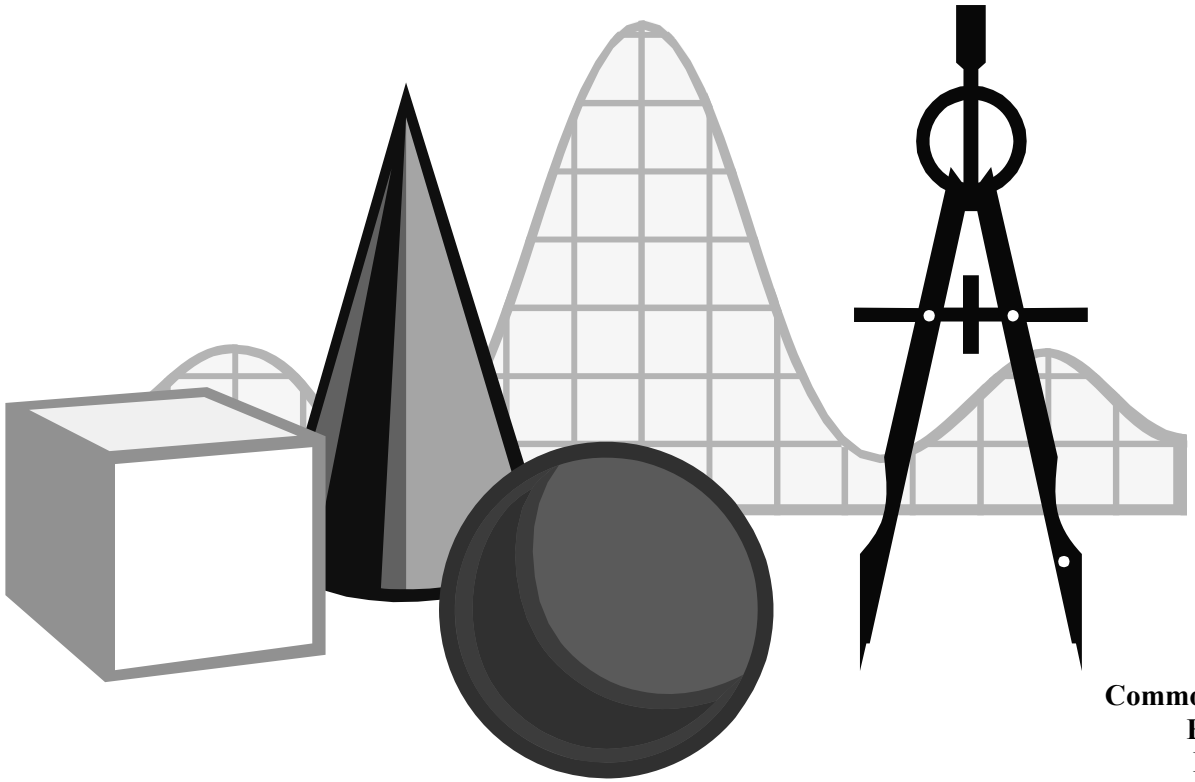
a) investigate the identity and the commutative properties for addition and multiplication; and

b) identify examples of the identity and commutative properties for addition and multiplication.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
		mathematical relationships (e.g., ~~$4 \cdot 3 = 2 \cdot 6$~~ $4 \times 3 = 14 - 2$). • Identify examples of the identity and commutative properties for addition and multiplication. • Identify number sentences that show appropriate use of the equal~~s~~ sign and the not equal sign. $6 \times 8 \neq 36 - 4$ $123 \neq 132$ $18 + 4 + 2 \neq 24 \div 6$ $36 - 14 = 11 \times 2$ $49 - 0 = 7 \times 7$

MATHEMATICS STANDARDS OF LEARNING CURRICULUM FRAMEWORK

Grade 4



Commonwealth of Virginia
Board of Education
Richmond, Virginia
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The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

Mathematics instruction in grades 4 and 5 should continue to foster the development of number sense, especially with decimals and fractions. Students with good number sense understand the meaning of numbers, develop multiple relationships and representations among numbers, and recognize the relative magnitude of numbers. They should learn the relative effect of operating on whole numbers, fractions, and decimals and learn how to use mathematical symbols and language to represent problem situations. Number and operation sense continues to be the cornerstone of the curriculum.

The focus of instruction at grades 4 and 5 allows students to investigate and develop an understanding of number sense by modeling numbers, using different representations (e.g., physical materials, diagrams, mathematical symbols, and word names). Students should develop strategies for reading, writing, and judging the size of whole numbers, fractions, and decimals by comparing them, using a variety of models and benchmarks as referents (e.g., $\frac{1}{2}$ or 0.5). Students should apply their knowledge of number and number sense to investigate and solve problems.

4.1 The student will

a) identify orally and in writing the place value for each digit in a whole number expressed through millions;
b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and
c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The structure of the ~~b~~Base-10 number system is based upon a simple pattern of tens, in which the value of each place is ten times the value of the place to its right. • Place value refers to the value of each digit and depends upon the position of the digit in the number. For example, in the number 7,864,352, the eight is in the hundred thousands place, and the value of the 8 is eight hundred thousand or 800,000. • Whole numbers may be written in a variety of formats: – Standard: 1,234,567 – Written: one million, two hundred thirty-four thousand, five hundred sixty-seven – Expanded: (1 × 1,000,000) + (2 × 100,000) + (3 × 10,000) + (4 × 1,000) + (5 × 100) + (6 × 10) + (7 × 1) • Numbers are arranged into groups of three places called *periods* (ones, thousands, millions, …). Places within the periods repeat (hundreds, tens, ones). Commas are used to separate the periods. Knowing the place value and period of a number helps students find values of digits in any number as well as read and write numbers. • Reading and writing large numbers should be ~~related to numbers that have~~ meaning~~s~~ful for students. Experiences can be provided that relate	**All students should** • Understand the relationships in the place value system in which the value of each place is ten times the value of the place to its right. • Use the patterns in the place value system to read and write numbers. • Understand that reading place value correctly is essential when comparing numbers. • Understand that rounding gives a close number to use when exact numbers are not needed for the situation at hand. • Develop strategies for rounding.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify and communicate, both orally and in written form, the placed value for each digit in whole numbers expressed through the one millions place. • Read whole numbers through the one millions place that are presented in standard format, and select the matching number in written format. • Write whole numbers through the one millions place in standard format when the numbers are presented orally or in written format. • Identify and use the symbols for *greater than*, *less than*, and *equal to*. • Compare two whole numbers expressed through the one millions, using symbols >, <, or =. • Round whole numbers expressed through the one millions place to the nearest thousand, ten thousand, and hundred-thousand place.

4.1 The student will

a) identify orally and in writing the place value for each digit in a whole number expressed through millions;
b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and
c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
practical situations (e.g., numbers found in the students' environment including population, number of school lunches sold statewide in a day, etc.). Concrete materials such as ~~b~~Base-10 blocks and bundles of sticks may be used to represent whole numbers through thousands. Larger numbers may be represented by ~~symbol~~ digit cards and place value charts. • Mathematical symbols (>, <) used to compare two unequal numbers are called *inequality symbols*. • A procedure for comparing two numbers by examining place value may include the following: ~~Line up the numbers by place value by lining up the ones.~~ ~~Beginning at the left, find the first place value where the digits are different.~~ – Compare the digits in ~~this place value~~ the numbers to determine which number is greater (or which is less). – Use a number line to identify the appropriate placement of the numbers based on the place value of the digits. – Use the appropriate symbol > or < or words *greater than* or *less than* to compare the numbers in the order in which they are presented. – If both numbers ~~are the same~~ have the same value, use the symbol = or words *equal to*.		

4.1 The student will

a) identify orally and in writing the place value for each digit in a whole number expressed through millions;
b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and
c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A strategy for rounding numbers to the nearest thousand, ten thousand, and hundred thousand is as follows: – Use a number line to determine the rounded number (e.g., when rounding 4,367,925 to the nearest thousand, identify the 'thousands' the number would fall between on the number line, then determine the thousand that the number is closest to): 4,367**,000** ? 4,368**,000** ←——————→ – Look one place to the right of the digit to which you wish to round. – If the digit is less than 5, leave the digit in the rounding place as it is, and change the digits to the right of the rounding place to zero. – If the digit is 5 or greater, add 1 to the digit in the rounding place and change the digits to the right of the rounding place to zero.		

4.2 The student will

a) compare and order fractions and mixed numbers;
b) represent equivalent fractions; and
c) identify the division statement that represents a fraction.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Rational numbers should be explained as any number that can be written as a fraction (e.g., $\frac{2}{1}$, $\frac{2}{3}$, $7\frac{1}{4}$).~~ • A fraction is a way of representing part of a whole (as in a region/area model or a measurement model) or part of a group (as in a set model). A fraction is used to name a part of one thing or a part of a collection of things. • In ~~each~~ the area/region and length/measurement fraction models, the parts must be equal ~~(i.e., each pie piece must have the same area; the size of each chip in a set must be equal; the measures such as the colored multi-length rods, or the parts in a fraction strip must be equal)~~. In the set model, the elements of the set do not have to be equal (i.e., "What fraction of the class is wearing the color red?"). • The denominator ~~(bottom number)~~ tells how many equal parts are in the whole or set. The numerator ~~(top number)~~ tells how many of those parts are being counted or described. • When fractions have the same denominator, they are said to have "common denominators" or "like denominators." Comparing fractions with like denominators involves comparing only the numerators.	**All students should** • Develop an understanding of fractions as parts of unit wholes, as parts of a collection, and as locations on a number line. • Understand that a mixed number is a fraction that has two parts: a whole number and a proper fraction. The mixed number is the sum of these two parts. • Use models, benchmarks, and equivalent forms to judge the size of fractions. • Recognize that a whole divided into nine equal parts has smaller parts than if the whole had been divided into five equal parts. • Recognize and generate equivalent forms of commonly used fractions and decimals. • Understand the division statement that represents a fraction. • Understand that the more parts the whole is divided into, the smaller the parts (e.g., $\frac{1}{5} < \frac{1}{3}$).	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify, model, and compare fractions and mixed numbers through twelfths, using~~ ~~- region/area models (e.g., fraction circles, pattern blocks, geoboards, color tiles, graph paper);~~ ~~- set models (e.g., two-sided counters, chips); and~~ ~~- measurement models (e.g., cuisenaire rods, unifix cubes, fraction strips, number lines).~~ • Compare and order fractions having denominators of 12 or less, using manipulative models and drawings, such as region/area models ~~(e.g., fraction circles, pattern blocks, geoboards, color tiles, graph paper, drawings); set models (e.g., two-sided counters, chips, drawings); and measurement models (e.g., colored, multilength rods, linking cubes, fraction strips, rulers/number lines, drawings)~~. • Compare and order fractions with like denominators by comparing number of parts (numerators) (e.g., $\frac{1}{5} < \frac{3}{5}$). • Compare and order fractions with like numerators and unlike denominators by comparing the size of the parts (e.g., $\frac{3}{9} < \frac{3}{5}$). • Compare and order fractions having unlike denominators of 12 or less by comparing the fractions to benchmarks

4.2 The student will

a) compare and order fractions and mixed numbers;
b) represent equivalent fractions; and
c) identify the division statement that represents a fraction.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Strategies for comparing fractions having unlike denominators may include – comparing fractions to familiar benchmarks (e.g., 0, $\frac{1}{2}$, 1); – finding equivalent fractions, using manipulative models such as fraction strips, number lines, fraction circles, ~~cuisenaire~~ rods, pattern blocks, ~~unifix~~ cubes, ~~b~~Base-10 blocks, tangrams, ~~or~~ graph paper, or a multiplication chart and patterns; and – finding a common denominator by finding the least common multiple (LCM) of both denominators and then rewriting each fraction as an equivalent fraction, using the LCM as the denominator. • A variety of fraction models should be used to expand students' understanding of fractions and mixed numbers: – Region/area models: a surface or area is subdivided into smaller equal parts, and each part is compared with the whole (e.g., fraction circles, pattern blocks, geoboards, grid paper, color tiles). – Set models: the whole is understood to be a set of objects, and subsets of the whole make up fractional parts (e.g., counters, chips). – Measurement models: similar to area models but lengths instead of areas are compared		(e.g., 0, $\frac{1}{2}$ or 1) to determine their relationships to the benchmarks or by finding a common denominator. • Compare and order mixed numbers having denominators of 12 or less. • Use the symbols >, <, and = to compare the numerical value of fractions and mixed numbers having denominators of 12 or less. • ~~Represent fractions for halves, fourths, fifths, and tenths as decimals through thousandths, using concrete objects (e.g., demonstrate the relationship between the fraction $\frac{1}{4}$ and its decimal equivalent 0.25).~~ • ~~Relate fractions to decimals, using concrete objects (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, money [coins]).~~ • ~~Identify and represent~~ Represent equivalent fractions through twelfths, using region/area models, set models, and measurement models. • Identify the division statement that represents a fraction (e.g., $\frac{3}{5}$ means the same as 3 divided by 5).

4.2 The student will

a) compare and order fractions and mixed numbers;
b) represent equivalent fractions; and
c) identify the division statement that represents a fraction.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
(e.g., fraction strips, ~~cuisenaire~~ rods, ~~unifix~~ cubes, number lines, rulers). • A mixed number has two parts: a whole number and a fraction. • Equivalent fractions name the same amount. Students should use a variety of models to identify different names for equivalent fractions. • Students should focus on finding equivalent fractions of familiar fractions such as halves, thirds, fourths, sixths, eighths, tenths, and twelfths. • Decimals and fractions represent the same relationships; however, they are presented in two different formats. The decimal 0.25 is written as $\frac{1}{4}$. ~~Decimal numbers are another way of writing fractions. The base-10 models concretely relate fractions to decimals (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, money).~~ When presented with the fraction $\frac{3}{5}$, the division expression representing a fraction is written as 3 divided by 5.		

4.3 The student will

a) read, write, represent, and identify decimals expressed through thousandths;
b) round decimals to the nearest whole number, tenth, and hundredth;
c) compare and order decimals; and
d) given a model, write the decimal and fraction equivalents.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The structure of the ~~b~~Base-10 number system is based upon a simple pattern of tens, where each place is ten times the value of the place to its right. This is known as a ten-to-one place value relationship. • Understanding the system of tens means that ten tenths represents one whole, ten hundredths represents one tenth, ten thousandths represents one hundredth. • A decimal point separates the whole number places from the places that are less than one. Place values extend infinitely in two directions from a decimal point. A number containing a decimal point is called a *decimal number* or simply a *decimal*. • To read decimals, – read the whole number to the left of the decimal point, if there is one; – read the decimal point as "and"; – read the digits to the right of the decimal point just as you would read a whole number; and – say the name of the place value of the digit in the smallest place. • Any decimal less than 1 will include a leading zero (e.g., 0.125). • Decimals may be written in a variety of forms: – Standard: 26.537 – Written: twenty-six and five hundred thirty-seven thousandths – Expanded: $(2 \times 10) + (6 \times 1) + (5 \times 0.1) + (3 \times 0.01) +$	**All students should** • Understand the place value structure of decimals and use this structure to read, write, and compare decimals. • Understand that decimal numbers can be rounded to an estimate when exact numbers are not needed for the situation at hand. • Understand that decimals are rounded in a way that is similar to the way whole numbers are rounded. • Understand that decimals and fractions represent the same relationship; however, they are presented in two different formats. • Understand that models are used to show decimal and fraction equivalents.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Investigate the ten-to-one place value relationship for decimals through thousandths, using ~~b~~Base-10 manipulatives (e.g., place value mats/charts, decimal squares, ~~b~~Base-10 blocks, money). • Represent and identify decimals expressed through thousandths, using ~~b~~Base-10 manipulatives, pictorial representations, ~~calculators~~, and numerical symbols (e.g., relate the appropriate drawing to 0.05). • Identify and communicate, both orally and in written form, the position and value of a decimal through thousandths. For example, in 0.385, the 8 is in the hundredths place and has a value of 0.08. • Read and write decimals expressed through thousandths, using ~~b~~Base-10 manipulatives, drawings, ~~calculators~~, and numerical symbols. ~~Any decimal less than 1 will include a leading zero (e.g., 0.125).~~ • Round decimals to the nearest whole number, tenth, and hundredth. • Compare ~~and order~~ ~~the value of~~ ~~two~~ decimals, using the symbols >, <, =. • Order a set of decimals from least to greatest or greatest to least.

4.3 The student will

a) read, write, represent, and identify decimals expressed through thousandths;
b) round decimals to the nearest whole number, tenth, and hundredth;
c) compare and order decimals; and
d) given a model, write the decimal and fraction equivalents.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
(7 × 0.001). • Decimals and fractions represent the same relationships; however, they are presented in two different formats. The decimal 0.25 is written as $\frac{1}{4}$. Decimal numbers are another way of writing fractions. When presented with the fraction $\frac{3}{5}$, the division expression representing a fraction is written as 3 divided by 5. The ~~b~~Base-10 models concretely relate fractions to decimals (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, money). • The procedure for rounding decimal numbers is similar to the procedure for rounding whole numbers. • A strategy for rounding decimal numbers to the nearest tenth and hundredth is as follows: – Look one place to the right of the digit you want to round to. – If the digit is 5 or greater, add 1 to the digit in the rounding place, and drop the digits to the right of the rounding place. – If the digit is less than 5, leave the digit in the rounding place as it is, and drop the digits to the right of the rounding place. • Different strategies for rounding decimals include: – Use a number line to locate a decimal between two numbers. For example, 18.83 is closer to 18.8 than to 18.9. – Compare the digits in ~~this~~ the numbers to determine which number is greater (or which is less).		• Represent fractions for halves, fourths, fifths, and tenths as decimals through ~~thousandths~~ hundredths, using concrete objects (e.g., demonstrate the relationship between the fraction $\frac{1}{4}$ and its decimal equivalent 0.25). • Relate fractions to decimals, using concrete objects (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, decimal circles, money [coins]). • Write the decimal and fraction equivalent for a given model (e.g., $\frac{1}{4}$ = 0.25 or 0.25 = $\frac{1}{4}$)

4.3 The student will

a) read, write, represent, and identify decimals expressed through thousandths;
b) round decimals to the nearest whole number, tenth, and hundredth;
c) compare and order decimals; and
d) given a model, write the decimal and fraction equivalents.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
– Compare the value of decimals, using the symbols >, <, = (e.g., 0.83 > 0.8 or 0.19 < 0.2). – Order the value of decimals, from least to greatest and greatest to least (e.g., 0.83, 0.821, 0.8). • Decimal numbers are another way of writing fractions (halves, fourths, fifths, and tenths). The ~~b~~Base-10 models concretely relate fractions to decimals (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, decimal circles money). • Provide a fraction model (halves, fourths, fifths, and tenths) and ask students for its decimal equivalent. • Provide a decimal model and ask students for its fraction equivalent (halves, fourths, fifths, and tenths).		

Computation and estimation in grades 4 and 5 should focus on developing fluency in multiplication and division with whole numbers and should begin to extend students' understanding of these operations to work~~ing~~ with ~~fractions and~~ decimals. Instruction should focus on computation activities that enable students to model, explain, and develop ~~reasonable~~ proficiency with basic facts and algorithms. These proficiencies are often developed as a result of investigations and opportunities to develop algorithms. Additionally, opportunities to develop and use visual models, benchmarks, and equivalents, to add and subtract with common fractions, and to develop computational procedures for the addition and subtraction of decimals are a priority for instruction in these grades.

Students should develop an understanding of how whole numbers, fractions, and decimals are written and modeled; an understanding of the meaning of multiplication and division, including multiple representations (e.g., multiplication as repeated addition or as an array); an ability to identify and use relationships between operations to solve problems (e.g., multiplication as the inverse of division); and the ability to use (not identify) properties of operations to solve problems [e.g., 7×28 is equivalent to $(7 \times 20) + (7 \times 8)$~~, or $(7 \times 30) - (7 \times 2)$~~].

Students should develop computational estimation strategies based on an understanding of number concepts, properties, and relationships. Practice should include estimation of sums and differences of common fractions and decimals, using benchmarks (e.g., $\frac{2}{5} + \frac{1}{3}$ must be less than 1 because both fractions are less than $\frac{1}{2}$). Using estimation, students should develop strategies to recognize the reasonableness of their computations. Additionally, students should enhance their ability to select an appropriate problem solving method from among estimation, mental mathematics, paper-and-pencil algorithms, and the use of calculators and computers. With activities that challenge students to use this knowledge and these skills to solve problems in many contexts, students develop the foundation to ensure success and achievement in higher mathematics.

4.4 The student will

a) estimate sums, differences, products, and quotients of whole numbers;
b) add, subtract, and multiply whole numbers;
c) divide whole numbers, finding quotients with and without remainders; and
d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A sum is the result of adding two or more numbers. • A difference is the amount that remains after one quantity is subtracted from another. • An estimate is a number close to an exact ~~amount~~ solution. An estimate tells about how much or about how many. • Different strategies for estimating include using compatible numbers to estimate sums and differences and using front-end estimation for sums and differences. – Compatible numbers are numbers that are easy to work with mentally. Number pairs that are easy to add or subtract are compatible. When estimating a sum, replace actual numbers with compatible numbers (e.g., 52 + 74 can be estimated by using the compatible numbers 50 + 75). When estimating a difference, use numbers that are close to the original numbers. Tens and hundreds are easy to subtract (e.g., 83 – 38 is close to 80 – 40). – The front-end strategy for estimating is computing with the front digits. Front-end estimation for addition can be used even when the addends have a different number	**All students should** • Develop and use strategies to estimate whole number sums and differences and to judge the reasonableness of such results. • Understand that addition and subtraction are inverse operations. • Understand that division is the operation of making equal groups or equal shares. When the original amount and the number of shares are known, divide to find the size of each share. When the original amount and the size of each share are known, divide to find the number of shares. • Understand that multiplication and division are inverse operations. • Understand various representations of division and the terms used in division are *dividend*, *divisor*, and *quotient*. *dividend* ÷ *divisor* = *quotient* *quotient* *divisor*)*dividend* • Understand how to solve single-step and multistep problems using whole number operations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Estimate whole number sums, ~~and~~ differences, products, and quotients ~~using rounding, front-end strategies, and compatible number strategies. Describe the method of estimation used~~. • Refine estimates by adjusting the final amount, using terms such as *closer to, between*, and *a little more than*. • Determine the sum or difference of two whole numbers, each 999,999 or less, in vertical and horizontal form with or without regrouping, using paper and pencil, and using a calculator. • Estimate and find the products of two whole numbers when one factor has two digits or fewer and the other factor has three digits or fewer, using paper and pencil and calculators. • Estimate and find the quotient of two whole numbers, given a one-digit divisor and a two- or three-digit dividend. • Solve single-step and multistep problems using whole number operations. • Verify the reasonableness of sums, differences, products, and quotients of whole numbers using estimation.

4.4 The student will

a) estimate sums, differences, products, and quotients of whole numbers;
b) add, subtract, and multiply whole numbers;
c) divide whole numbers, finding quotients with and without remainders; and
d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
of digits. The procedure requires the addition of the values of the digits in the greatest of the smallest number. For example: 2367 → 2300 243 → 200 + 1186 → + 1100 3600 • Front-end or leading-digit estimation always gives a sum less than the actual sum; however, the estimate can be adjusted or refined so that it is closer to the actual sum. • Addition is the combining of quantities; it uses the following terms: *addend* → 45,623 *addend* → + 37,846 *sum* → 83,469 • Subtraction is the inverse of addition; it yields the difference between two numbers and uses the following terms: *minuend* → 45,698 *subtrahend* → – 32,741 *difference* → 12,957 • Before adding or subtracting with paper and pencil, addition and subtraction problems in horizontal form should be rewritten in vertical		

4.4 The student will

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UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
form by lining up the places vertically. • Using ~~b~~Base-10 materials to model and stimulate discussion about a variety of problem situations helps students understand regrouping and enables them to move from the concrete to the pictorial, to the abstract. Regrouping is used in addition and subtraction algorithms. In addition, when the sum in a place is 10 or more, is used to regroup the sums so that there is only one digit in each place. In subtraction, when the number (minuend) in a place is not enough from which to subtract, regrouping is required. • A certain amount of practice is necessary to develop fluency with computational strategies for multidigit numbers; however, the practice must be meaningful, motivating, and systematic if students are to develop fluency in computation, whether mentally, with manipulative materials, or with paper and pencil. • Calculators are an appropriate tool for computing sums and differences of large numbers, particularly when mastery of the algorithm has been demonstrated.		

4.4 The student will

a) estimate sums, differences, products, and quotients of whole numbers;
b) add, subtract, and multiply whole numbers;
c) divide whole numbers, finding quotients with and without remainders; and
d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The terms associated with multiplication are *factor* → 376 *factor* → × 23 *product* → 8,648 • One model of multiplication is repeated addition. • Another model of multiplication is the "Partial Product" model. 24 × 3 12 ← Multiply the ones: 3 × 4 = 12 + 60 ← Multiply the tens: 3 × 20 = 60 72 • Another model of multiplication is the "Area Model" (which also represents partial products) and should be modeled first with Base-10 blocks. (e.g., 23 x 68) • Students should continue to develop fluency with single-digit multiplication facts and their related division facts. • Calculators should be used to solve problems that require tedious calculations. • Estimation should be used to check the reasonableness of the product. Examples of estimation strategies include the following:		

4.4 The student will

a) estimate sums, differences, products, and quotients of whole numbers;
b) add, subtract, and multiply whole numbers;
c) divide whole numbers, finding quotients with and without remainders; and
d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
– The front-end method: multiply the front digits and then complete the product by recording the number of zeros found in the factors. It is important to develop understanding of this process before using the step-by-step procedure. 523 → 500 × 31 → × 30 15,000 – This is 3 × 5 = 15 with 3 zeros. – Compatible numbers: replace factors with compatible numbers, and then multiply. Opportunities for students to discover patterns with 10 and powers of 10 should be provided. 64 → 64 × 11 → × 10 • Division is the operation of making equal groups or equal shares. When the original amount and the number of shares are known, divide to find the size of each share. When the original amount and the size of each share are known, divide to find the number of shares. Both situations may be modeled with ~~b~~Base-10 manipulatives. • Multiplication and division are inverse operations. • Terms used in division are *dividend, divisor*, and *quotient.*		

4.4 The student will

a) estimate sums, differences, products, and quotients of whole numbers;
b) add, subtract, and multiply whole numbers;
c) divide whole numbers, finding quotients with and without remainders; and
d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
dividend ÷ divisor = quotient quotient divisor)dividend • Opportunities to invent division algorithms help students make sense of the algorithm. Teachers should teach division by various methods such as repeated multiplication and subtraction (partial quotients) before teaching the traditional long division algorithm.		

4.5 The student will

a) determine common multiples and factors, including least common multiple and greatest common factor;

b) add and subtract fractions having like and unlike denominators that are limited to 2, 3, 4, 5, 6, 8, 10, and 12, and simplify the resulting fractions, using common multiples and factors;

c) add and subtract with decimals; and

d) solve single-step and multistep practical problems involving addition and subtraction with fractions and with decimals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A factor of a number is an integer that ~~divides evenly into that number~~ ~~has~~ divides evenly into that number with a remainder of zero. • A factor of a number is a divisor of the number. • A multiple of a number is the product of the number and any natural number. • A common factor of ~~two or more numbers~~ two or more numbers ~~a number~~ is a divisor that all of the numbers share. • The least common multiple of two or more numbers is the smallest common multiple of the given numbers. • The greatest common factor of two or more numbers is the largest of the common factors that all of the numbers share. • Students should investigate addition and subtraction ~~of~~ with fractions, using a variety of models (e.g., fraction circles, fraction strips, rulers, ~~unifix~~ linking cubes, pattern blocks). • When adding or subtracting with fractions having like denominators, add or subtract the numerators and use the same denominator. Write the answer in simplest form using common multiples and factors. • When adding or subtracting with fractions having unlike	**All students should** • Understand and use common multiples and common factors for simplifying fractions. • Develop and use strategies to estimate addition and subtraction involving fractions and decimals. • Use visual models to add and subtract with fractions and decimals.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find common multiples and common factors of ~~two~~ numbers. • Determine the least common multiple and greatest common factor of ~~two~~ numbers. • Use least common multiple and/or greatest common factor to find a common denominator for ~~two~~ fractions. • Add and subtract with fractions having like denominators ~~of 12 or less, using concrete materials, pictorial representations, and paper and pencil~~ whose denominators are limited to 2, 3, 4, 5, 6, 8, 10, and 12, and simplify the resulting fraction using common multiples and factors. • Add and subtract with fractions having unlike denominators ~~of 12 or less, using concrete materials pictorial representations and paper and pencil~~ whose denominators are limited to 2, 3, 4, 5, 6, 8, 10, and 12, and simplify the resulting fraction using common multiples and factors. • Solve problems that involve adding and subtracting with fractions having like and unlike denominators ~~of~~

4.5 The student will

a) determine common multiples and factors, including least common multiple and greatest common factor;

b) add and subtract fractions having like and unlike denominators that are limited to 2, 3, 4, 5, 6, 8, 10, and 12, and simplify the resulting fractions, using common multiples and factors;

c) add and subtract with decimals; and

d) solve single-step and multistep practical problems involving addition and subtraction with fractions and with decimals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
denominators, rewrite them as fractions with a common denominator. The least common multiple (LCM) of the unlike denominators is a common denominator (LCD). Write the answer in simplest form using common multiples and factors. • Addition and subtraction of decimals may be explored, using a variety of models (e.g., 10-by-10 grids, number lines, money). • For decimal computation, the same ideas developed for whole number computation may be used, and these ideas may be applied to decimals, giving careful attention to the placement of the decimal point in the solution. Lining up tenths to tenths, hundredths to hundredths, etc. helps to establish the correct placement of the decimal. • Fractions may be related to decimals by using models (e.g., 10-by-10 grids, decimal squares, money).		~~12 or less.~~ whose denominators are limited to 2, 3, 4, 5, 6, 8, 10, and 12, and simplify the resulting fraction using common multiples and factors. • Add and subtract with decimals through thousandths, using concrete materials, pictorial representations, and paper and pencil. • Solve single-step and multistep problems that involve adding and subtracting with fractions and decimals through thousandths.

Students in grades 4 and 5 should be actively involved in measurement activities that require a dynamic interaction between students and their environment. Students can see the usefulness of measurement if classroom experiences focus on measuring objects and estimating measurements. Textbook experiences cannot substitute for activities that utilize measurement to answer questions about real problems.

The approximate nature of measurement deserves repeated attention at this level. It is important to begin to establish some benchmarks by which to estimate or judge the size of objects. ~~The intent is for students to make "ballpark" comparisons and *not* to memorize conversion factors between U.S. Customary and metric units. To fully understand these ballpark comparisons, students must be actively engaged in the process of measurement.~~

Students use standard and nonstandard, age-appropriate tools to measure objects. Students also use age-appropriate language of mathematics to verbalize the measurements of length, weight/mass, liquid volume, area, temperature, and time.

The focus of instruction should be an active exploration of the real world in order to apply concepts from the two systems of measurement (metric and U.S. Customary), to measure perimeter, weight/mass, liquid volume/capacity, area, temperature, and time. Students continue to enhance their understanding of measurement by using appropriate tools such as rulers, balances, clocks, and thermometers. The process of measuring is identical for any attribute (i.e., length, weight/mass, liquid volume/capacity, area): choose a unit, compare that unit to the object, and report the number of units.

4.6 The student will

a) estimate and measure weight/mass and describe the results in U.S. Customary and metric units as appropriate; and

b) identify equivalent measurements between units within the U.S. Customary system (ounces, pounds, and tons) and between units within the metric system (grams and kilograms).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Weight and mass are different. Mass is the amount of matter in an object. Weight is determined by the pull of gravity on the mass of an object. The mass of an object remains the same regardless of its location. The weight of an object changes depending on the gravitational pull at its location. In everyday life, most people are actually interested in determining an object's mass, although they use the term *weight* (e.g., "How much does it weigh?" versus "What is its mass?"). • Balances are appropriate measuring devices to measure weight in U.S. Customary units (ounces, pounds) and mass in metric units (grams, kilograms). • Practical experience measuring the mass of familiar objects helps to establish benchmarks and facilitates the student's ability to estimate weight/mass. • ~~Students may use familiar benchmarks to make ballpark comparisons, such as~~ ~~– 1 ounce is about 28 grams (a slice of bread weighs about 1 ounce);~~ ~~– 1 nickel has the mass of about 5 grams; and~~ ~~– 1 kilogram is a little more than 2 pounds (a textbook has a mass of about 1 kilogram).~~ • Students should estimate the mass/weight of everyday objects (e.g., foods, pencils, book bags, shoes), using appropriate metric or U.S. Customary units.	**All students should** • Use benchmarks to estimate and measure weight/mass. • Identify equivalent measures between units within the U.S. Customary and between units within the metric measurements.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine an appropriate unit of measure (e.g., ounce, pound, ton, gram, kilogram) to use when measuring everyday objects in both metric and U.S. Customary units. • Measure objects in both metric and U.S. Customary units (e.g., ounce, pound, ton, gram, or kilogram) to the nearest appropriate measure, using a variety of measuring instruments. • Record the mass of an object including the appropriate unit of measure (e.g., 24 grams). • ~~Estimate conversions between U.S. Customary and metric units, using ballpark comparisons, such as~~ ~~– 1 ounce is about 28 grams;~~ ~~– 1 nickel has the mass of about 5 grams; and~~ ~~– 1 kilogram is a little more than 2 pounds.~~

4.7 The student will

a) estimate and measure length, and describe the result in both metric and U.S. Customary units; and

b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards; yards and miles) and between units within the metric system (millimeters and centimeters; centimeters and meters; and millimeters and meters).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Length is the distance along a line or figure from one point to another. • U.S. Customary units for measurement of length include inches, feet, yards, and miles. Appropriate measuring devices include rulers, yardsticks, and tape measures. Metric units for measurement of length include millimeters, centimeters, meters, and kilometers. Appropriate measuring devices include centimeter ruler~~s~~, meter stick~~s~~, and tape~~s~~ measure. • Practical experience measuring the length of familiar objects helps to establish benchmarks and facilitates the student's ability to estimate length. ~~• Students may use familiar benchmarks to make ballpark comparisons, such as~~ ~~– 1 inch is about 2.5 centimeters (the diameter of a quarter is about 1 inch);~~ ~~– 1 meter is a little longer than 1 yard (a doorway is about a yard in width); and~~ ~~– 1 mile is slightly farther than 1.5 kilometers, or 1 kilometer is slightly farther than half a mile.~~ • Students should estimate the length of everyday objects (e.g., books, windows, tables) in both metric and U.S. Customary units of measure.	**All students should** • Use benchmarks to estimate and measure length. • Understand how to convert units of length between the U.S. Customary and metric systems, using ballpark comparisons. • Understand the relationship between U.S. Customary units and the relationship between metric units.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine an appropriate unit of measure (e.g., inch, foot, yard, mile, millimeter, centimeter, and meter) to use when measuring everyday objects in both metric and U.S. Customary units. • Estimate the length of everyday objects (e.g., books, windows, tables) in both metric and U.S. Customary units of measure. • Measure the length~~s~~ of objects in both metric and U.S. Customary units, measuring to the nearest inch ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$), foot, yard, mile, millimeter, centimeter, or meter, and record the length including the appropriate unit of measure (e.g., 24 inches). • Compare estimates of the length of objects with the actual measurement of the length of objects. • Identify equivalent measures of length between units within the U.S. Customary measurements and between units within the metric measurements. ~~Estimate conversions between the U.S. Customary and metric units, using ballpark comparisons, such as~~ ~~– 1 inch is about 2.5 centimeters;~~

4.7 The student will

a) estimate and measure length, and describe the result in both metric and U.S. Customary units; and

b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards; yards and miles) and between units within the metric system (millimeters and centimeters; centimeters and meters; and millimeters and meters).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• When measuring with U.S. Customary units, students should be able to measure to the nearest part of an inch ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$), inch, foot, or yard.		~~1 meter is a little longer than 1 yard;~~ ~~1 mile is slightly farther than 1.5 kilometers; and~~ ~~1 kilometer is slightly farther than half a mile.~~

4.8 The student will

a) estimate and measure liquid volume and describe the results in U.S. Customary units; and

b) identify equivalent measurements between units within the U.S. Customary system (cups, pints, quarts, and gallons).

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• U.S. Customary units for measurement of liquid volume include cups, pints, quarts, and gallons. ~~Metric units for measurement of liquid volume include milliliters and liters~~. • The measurement of the object must include the unit of measure along with the number of iterations. • Students should measure the liquid volume of everyday objects in ~~both metric and~~ U.S. Customary units, including cups, pints, quarts, gallons, ~~milliliters, and liters~~, and record the volume including the appropriate unit of measure (e.g., 24 gallons). • Practical experience measuring liquid volume of familiar objects helps to establish benchmarks and facilitates the student's ability to estimate liquid volume. ~~• Students may use familiar benchmarks to make ballpark comparisons, such as 1 quart is a little less than 1 liter, and 1 liter is a little more than 1 quart.~~ • Students should estimate the liquid volume of containers in ~~both metric and~~ U.S. Customary units to the nearest cup, pint, quart, and gallon~~, milliliter, or liter~~.	**All students should** • Use benchmarks to estimate and measure volume. • ~~Understand how to convert units of volume~~ Identify equivalent measurements between units within the U.S. Customary ~~and metric~~ systems~~, using ballpark comparisons~~.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine an appropriate unit of measure (cups, pints, quarts, gallons~~, milliliters, or liters~~) to use when measuring liquid volume in ~~both metric and~~ U.S. Customary units. • Estimate the liquid volume of containers in ~~both metric and~~ U.S. Customary units of measure to the nearest cup, pint, quart, and gallon~~, milliliter, or liter~~. • Measure the liquid volume of everyday objects in ~~both metric and~~ U.S. Customary units, including cups, pints, quarts, and gallons~~, milliliters, and liters~~, and record the volume including the appropriate unit of measure (e.g., 24 gallons). • Identify equivalent measures of volume between units within the U.S. Customary system ~~and metric measurements~~. ~~• Estimate conversion between U.S. Customary and metric units, using ballpark comparisons, such as 1 quart is a little less than 1 liter, and 1 liter is a little more than 1 quart.~~

4.9 The student will determine elapsed time in hours and minutes within a 12-hour period.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Elapsed time is the amount of time that has passed between two given times. • Elapsed time should be modeled and demonstrated using analog clocks and timelines. • Elapsed time can be found by counting on from the beginning time to the finishing time. – Count the number of whole hours between the beginning time and the finishing time. – Count the remaining minutes. – Add the hours and minutes. For example, to find the elapsed time between 10:15 a.m. and 1:25 p.m., count 10 minutes; and then, add 3 hours to 10 minutes to find the total elapsed time of 3 hours and 10 minutes.	**All students should** • Understanding the "counting on" strategy for determining elapsed time in hour and minute increments over a 12-hour period from a.m. to a.m. or p.m. to p.m.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine the elapsed time in hours and minutes within a 12-hour period (times can cross between a.m. and p.m. ~~times~~). • Solve practical problems in relation to time that has elapsed.

The study of geometry helps students represent and make sense of the world. At the fourth- and fifth-grade levels, reasoning skills typically grow rapidly, and these skills enable students to investigate geometric problems of increasing complexity and to study how geometric terms relate to geometric properties. Students develop knowledge about how geometric ~~shapes~~ figures relate to each other and begin to use mathematical reasoning to analyze and justify properties and relationships among ~~shapes~~ figures.

Students discover these relationships by constructing, drawing, measuring, comparing, and classifying geometric ~~shapes~~ figures. Investigations should include explorations with everyday objects and other physical materials. Exercises that ask students to visualize, draw, and compare ~~shapes~~ figures will help them not only to develop an understanding of the relationships, but to develop their spatial sense as well. ~~Discussing ideas, conjecturing, and testing hypotheses precede the development of more formal summary statements.~~ In the process, definitions become meaningful, relationships among figures are understood, and students are prepared to use these ideas to develop informal arguments.

Students investigate, identify, and draw representations and describe the relationships between and among points, lines, line segments, rays, and angles. Students apply generalizations about lines, angles, and triangles to develop understanding about congruence, other lines such as parallel and perpendicular ones, and classifications of triangles. ~~Students also explore coordinate geometry, using the coordinate plane to describe points in the first quadrant.~~

The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.)
- **Level 3: Abstraction.** Definitions are meaningful, with relationships being perceived between properties and between figures. Logical implications and class inclusions are understood, but the role and significance of deduction is not understood. (Students should transition to this level during grades 5 and 6 and fully attain it before taking ~~A~~algebra.)

4.10 The student will

a) identify and describe representations of points, lines, line segments, rays, and angles, including endpoints and vertices; and

b) identify representations of lines that illustrate intersection, parallelism, and perpendicularity.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A point is ~~an exact~~ a location in space. It has no length, ~~or~~ width, or height. A point is usually named with a capital letter. • A line is a collection of points going on and on infinitely in both directions. It has no endpoints. ~~A line is a collection of points going on and on infinitely in both directions. It has no endpoints.~~ When a line is drawn, at least two points on it can be marked and given capital letter names. ~~The line can also be named with a single, lower-case letter~~. ~~Arrowheads~~ Arrows must be drawn to show that the line goes on in both directions infinitely (e.g., $\overleftrightarrow{AB}$, read as "the line AB"). • A line segment is part of a line. It has two endpoints and includes all the points between those endpoints. To name a line segment, name the endpoints (e.g., $\overline{AB}$, read as "the line segment AB"). • A ray is part of a line. It has one endpoint and continues ~~on and on~~ infinitely in one direction. To name a ray, say the name of its endpoint first and then say the name of one other point on the ray (e.g., $\overrightarrow{AB}$, read as "the ray AB"). • Two rays that have the same endpoint form an angle. This endpoint is called the *vertex*. Angles are found wherever lines and line segments intersect. An angle can be named in three different ways by using	**All students should** • Understand that points, lines, line segments, ~~and~~ rays, and angles, including endpoints and vertices are fundamental components of noncircular geometric figures. • Understand that the shortest distance between two points on a flat surface is a line segment. • Understand that lines in a plane either intersect or are parallel. Perpendicularity is a special case of intersection. • Identify ~~real-world~~ practical situations that illustrate parallel, intersecting, and perpendicular lines.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Differentiate among a point, line, line segment, and ray by using the definitions to compare.~~ • ~~Investigate and describe~~ Identify and describe ~~the relationships between and among~~ representations of points, lines, line segments, ~~and~~ rays, and angles, including endpoints and vertices. • Understand that lines in a plane can intersect or are parallel. Perpendicularity is a special case of intersection. • Identify practical situations that illustrate parallel, intersecting, and perpendicular lines.

4.10 The student will

a) identify and describe representations of points, lines, line segments, rays, and angles, including endpoints and vertices; and

b) identify representations of lines that illustrate intersection, parallelism, and perpendicularity.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
– three letters to name, in this order, a point on one ray, the vertex, and a point on the other ray; – one letter at the vertex; or – a number written inside the rays of the angle. • Intersecting lines ~~are lines that cross and~~ have one point in common. • Perpendicular lines are special intersecting lines that form right angles ~~(square corners)~~ where they intersect. • Parallel lines are lines that lie ~~on the same flat~~ in the same place ~~surface (plane) and never cross~~ and do not intersect. Parallel lines are always the same distance apart and do not share any points. • Students should explore intersection, parallelism, and perpendicularity in both two and three dimensions. For example, students should analyze the relationships between the edges of a cube. Which ~~line segments~~ edges are parallel? Which are perpendicular? What plane contains the upper left edge and the lower right edge of the cube? Students can visualize this by using the classroom itself to notice the lines formed by the intersection of the ceiling and walls, of the floor and wall, and of two walls.		

4.11 The student will

a) investigate congruence of plane figures after geometric transformations, such as reflection, translation, and rotation, using mirrors, paper folding, and tracing; and

b) recognize the images of figures resulting from geometric transformations, such as translation, reflection, and rotation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding. – **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons. – **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.) – **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.) – **Level 3: Abstraction.** Definitions are meaningful, with relationships being perceived between properties and between figures. Logical implications and class inclusion are understood, but the role and significance of deduction is not	**All students should** • ~~Understand that two-dimensional (plane) figures are unique in their defining properties.~~ • ~~Understand that three-dimensional (solid) figures are unique in their defining properties~~. • Understand the meaning of the term *congruent*. • Understand how to identify congruent ~~shapes~~ figures. • Understand that the orientation of figures does not affect congruency or noncongruency.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify and describe the properties of squares, rectangles, triangles, parallelograms, rhombi, and circles.~~ • ~~Identify and describe the properties of spheres, cubes, and rectangular solids (prisms).~~ • ~~Identify congruent and noncongruent figures.~~ • ~~Analyze and compare the properties of circles and spheres; squares and cubes; and rectangles and rectangular solids (prisms).~~ • Recognize the congruence of plane figures resulting from geometric transformations such as translation, reflection, and rotation, using mirrors, paper folding and tracing.

4.11 The student will

a) investigate congruence of plane figures after geometric transformations, such as reflection, translation, and rotation, using mirrors, paper folding, and tracing; and

b) recognize the images of figures resulting from geometric transformations, such as translation, reflection, and rotation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
understood. (Students should transition to this level during grades 5 and 6 and fully attain it before taking algebra.) • ~~A polygon is a two-dimensional geometric figure which has straight sides and can be described as simple and closed.~~ • ~~A triangle is a polygon with three angles and three sides.~~ • ~~A quadrilateral is a polygon with four sides.~~ • ~~A rectangle is a quadrilateral with four right angles.~~ • ~~A square is a rectangle with four sides of equal length.~~ • ~~A circle is a closed curve with all points in one plane and equidistant from a fixed point (the center).~~ • Congruent figures are figures having exactly the same size and shape. Opportunities for exploring figures that are congruent and/or noncongruent can best be accomplished by using physical models. • ~~A cube is a three-dimensional solid with six congruent square faces and every edge the same length. A cube has 6 faces and 12 edges.~~ • ~~A cylinder is a three-dimensional object formed by two congruent parallel circles joined by a curved surface (usually a solid or hollow object~~		

4.11 The student will

a) investigate congruence of plane figures after geometric transformations, such as reflection, translation, and rotation, using mirrors, paper folding, and tracing; and

b) recognize the images of figures resulting from geometric transformations, such as translation, reflection, and rotation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~shaped like a can).~~ • ~~A cone is a solid, pointed figure having a flat, round base (usually a circle) that is joined to a vertex by a curved surface.~~ • ~~A rectangular solid (prism) is a three-dimensional figure in which all six faces are rectangles with three pair of parallel, congruent opposite faces.~~ • ~~A square pyramid is a solid whose base is a square and whose faces are triangles that share a common vertex.~~ • ~~A sphere is a three-dimensional object with all of its points the same distance from the center.~~ • A translation ~~(slide)~~ is a transformation in which an image is formed by moving every point on a figure the same distance in the same direction. • A reflection ~~(flip)~~ is a transformation in which a figure is flipped over a line called the *line of reflection*. All corresponding points in the image and preimage are equidistant from the line of reflection. • A rotation ~~(turn)~~ is a transformation in which an image is formed by turning its preimage about a point. • The resulting figure of a translation, reflection, or rotation is congruent to the original figure.		

4.12 The student will
a) define polygon; and
b) identify polygons with 10 or fewer sides.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A polygon is a ~~two-dimensional~~ closed plane geometric figure ~~which has straight sides and can be described as simple and closed~~ composed of at least three line segments that do not cross. None of the sides are curved. • A triangle is a polygon with three angles and three sides. • A quadrilateral is a polygon with four sides. • A rectangle is a quadrilateral with four right angles. • A square is a rectangle with four sides of equal length. • A trapezoid is a quadrilateral with exactly one pair of parallel sides. • A parallelogram is a quadrilateral with both pairs of opposite sides parallel. • A rhombus is a quadrilateral with 4 congruent sides. • A pentagon is a 5-sided polygon. • A hexagon is a 6-sided polygon. • A heptagon is a 7-sided polygon. • An octagon is an 8-sided polygon. • A nonagon is a 9-sided polygon. • A decagon is a 10-sided polygon.	**All students should** • Identify polygons with 10 or fewer sides in everyday situations. • Identify polygons with 10 or fewer sides in multiple orientations (rotations, reflections, and translations of the polygons).	**The student will use problem solving, mathematical communication, mathematical reasoning, connections and representation to** • Define and identify properties of polygons with 10 or fewer sides. • Identify polygons by name with 10 or fewer sides in multiple orientations (rotations, reflections, and translations of the polygons)

Students entering grades 4 and 5 have explored the concepts of chance and are able to determine possible outcomes of given events. Students have utilized a variety of random generator tools, including random number generators (number cubes), spinners, and two-sided counters. In game situations, students are able to predict whether the game is fair or not fair. Furthermore, students are able to identify events as likely or unlikely to happen. Thus the focus of instruction at grades 4 and 5 is to deepen their understanding of the concepts of probability by

- ~~developing the continuum of terms to include *impossible*, *unlikely*, *equally likely*, *possible*, and *certain*;~~
- offering opportunities to set up models simulating ~~real-life~~ practical events;
- engaging students in activities to enhance their understanding of fairness; and
- engaging students in activities ~~imbued~~ that instill ~~with~~ a spirit of investigation and exploration and providing students with opportunities to use manipulatives.

The focus of statistics instruction is to assist students with further development and investigation of data collection strategies. Students should continue to focus on

- posing questions;
- collecting data and organizing this data into meaningful graphs, charts, and diagrams based on issues relating to ~~real-world~~ practical experiences;
- interpreting the data presented by these graphs;
- answering descriptive questions (“How many?” “How much?”) from the data displays;
- identifying and justifying comparisons (“Which is the most? Which is the least?” “Which is the same?” “Which is different?”) about the information;
- comparing their initial predictions to the actual results; and
- writing a few sentences to communicate to others their ~~analysis and~~ interpretation of the data.

Through a study of probability and statistics, students develop a real appreciation of data analysis methods as powerful means for decision making.

4.13 The student will

a) predict the likelihood of an outcome of a simple event; and

b) represent probability as a number between 0 and 1, inclusive.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A spirit of investigation and experimentation should permeate probability instruction, where students are actively engaged in explorations and have opportunities to use manipulatives. • Probability is the chance of an event occurring. • The probability of an event occurring is the ratio of desired outcomes to the total number of possible outcomes. If all the outcomes of an event are equally likely to occur, the probability of the event = number of favorable outcomes / total number of possible outcomes. • The probability of an event occurring is represented by a ratio between 0 and 1. An event is "impossible" if it has a probability of 0 (e.g., the probability that the month of April will have 31 days). An event is "certain" if it has a probability of 1 (e.g., the probability that the sun will rise tomorrow morning). • When a probability experiment has very few trials, the results can be misleading. The more times an experiment is done, the closer the experimental probability comes to the theoretical probability (e.g., a coin lands heads up half of the time). • Students should have opportunities to describe in informal terms (i.e., *impossible*, *unlikely*, *as likely as unlikely*, *equally likely*, *likely*, and *certain*) the degree of likelihood of an event occurring.	**All students should** • Understand and apply basic concepts of probability. • Describe events as likely or unlikely and discuss the degree of likelihood, using the terms *certain*, *likely*, *equally likely*, *unlikely*, and *impossible*. • Predict the likelihood of an outcome of a simple event and test the prediction. • Understand that the measure of the probability of an event can be represented by a number between 0 and 1, inclusive.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Model and determine all possible outcomes of a given simple event where there are no more than ~~12~~ 24 possible outcomes, using a variety of manipulatives, such as coins, number cubes, and spinners. • Conduct experiments to determine the probability of an event occurring for a given number of trials (no more than ~~12~~ 25 trials), using manipulatives (e.g., the number of times "heads" occurs when flipping a coin 10 times; the chance that when the names of 12 classmates are put in a shoebox, a name that begins with *D* will be drawn). • Write the probability of a given simple event as a fraction, where the total number of possible outcomes is ~~12~~ 24 or fewer. • Identify the likelihood of an event occurring and relate it to its fractional representation (e.g., impossible/0; equally likely/$\frac{1}{2}$; certain/1). • ~~Set up a~~ Represent probability ~~number line showing that a number probability can be represented by~~ as a point between 0 and 1, inclusively, on a number line. • Determine the outcome of an event that is least likely to occur (less than half) or most likely to occur (greater than half) when the number of possible outcomes is 24 or less.

4.13 The student will

a) predict the likelihood of an outcome of a simple event; and

b) represent probability as a number between 0 and 1, inclusive.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
Activities should include ~~real-life~~ practical examples. • For ~~any~~ an event such as flipping a coin, the equally likely things that can happen are called *outcomes*. For example, there are two equally likely outcomes when flipping a coin: the coin can land heads up, or the coin can land tails up. • For another event such as spinning a spinner that is one-third red and two-thirds blue, the two outcomes, red and blue, are not equally likely. This is an unfair spinner (since it is not divided equally), therefore, the outcomes are not equally likely.		

4.14 The student will collect, organize, display, and interpret data from a variety of graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data analysis helps describe data, recognize patterns or trends, and make predictions. • Investigations involving ~~real-world~~ practical data should occur frequently, and data can be collected through brief class surveys or through more extended projects taking many days. • Students formulate questions, predict answers to questions under investigation, collect and represent initial data, and consider whether the data answer the questions. • Line graphs are used to show how two continuous variables are related. Line graphs ~~are~~ may be used to show how one variable changes over time. If this one variable is not continuous, then a broken line is used. By looking at a ~~single~~ line graph, it can be determined whether the variable is increasing, decreasing, or staying the same over time. – The values along the horizontal axis represent continuous data on a given variable, usually some measure of time (e.g., time in years, months, or days). The data presented on a line graph is referred to as "continuous data," as it represents data collected over a continuous period of time. – The values along the vertical axis are the scale and represent the frequency with which those values occur in the data set. The values should represent equal increments of multiples of whole numbers, fractions, or decimals, depending upon the data being collected. The scale should	**All students should** • Understand the difference between representing categorical data and representing numerical data. • Understand that line graphs show change over time (numerical data). • Understand that bar graphs should be used to compare counts of different categories (categorical data). • Understand how data displayed in bar and line graphs can be interpreted so that informed decisions can be made. • Understand that the title and labels of the graph provide the foundation for interpreting the data.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Collect data, using, for example, observations, measurement, surveys, scientific experiments, polls, or questionnaires. • Organize data into a chart or table. • Construct and display data in bar graphs, labeling one axis with equal whole number increments of 1 or more (numerical data) (e.g., ~~multiples of~~ 2, 5, 10, or 100) and the other axis with categories related to the title of the graph (categorical data) (e.g., swimming, fishing, boating, and water skiing as the categories of "Favorite Summer Sports"). • Construct and display data in line graphs, labeling the vertical axis with equal whole number increments of 1 or more and the horizontal axis with continuous data commonly related to time (e.g., hours, days, months, years, and age). Line graphs will have no more than ~~four~~ 10 identified points along a continuum for continuous data. For example, growth charts showing age versus height place age on the horizontal axis (e.g., 1 month, 2 months, 3 months, and 4 months). • Title ~~the given graph~~ or identify the title in a given graph and label or identify the axes. • ~~Analyze information~~ Interpret data from simple line and bar graphs by describing the characteristics of the data and the data as a whole (e.g., the category with the greatest/least, categories with the same number of responses, similarities and differences, the total number).

4.14 The student will collect, organize, display, and interpret data from a variety of graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
extend one increment above the greatest recorded piece of data. – Each axis should be labeled, and the graph should be given a title. – A line graph tells whether something has increased, decreased, or stayed the same with the passage of time. Statements representing an analysis and interpretation of the characteristics of the data in the graph should be included (e.g., trends of increase and/or decrease, and least and greatest). • Bar graphs should be used to compare counts of different categories (categorical data). Using grid paper ensures more accurate graphs. – A bar graph uses parallel, horizontal or vertical bars to represent counts for several categories. One bar is used for each category, with the length of the bar representing the count for that category. – There is space before, between, and after the bars. – The axis that displays the scale representing the count for the categories should extend one increment above the greatest recorded piece of data. Fourth-grade students should collect data that are recorded in increments of whole numbers, usually multiples of 1, 2, 5, ~~or~~ 10, or 100. – Each axis should be labeled, and the graph should be given a title. – Statements representing an analysis and interpretation of the characteristics of the data in the graph (e.g., similarities and differences, least and greatest, the		Data points will be limited to ~~20~~ 30 and categories to ~~4~~ 8. • Interpret the data to answer the question posed, and compare the answer to the prediction (e.g., "The summer sport preferred by most is swimming, which is what I predicted before collecting the data."). • Write at least one sentence to describe the analysis and interpretation of the data, identifying parts of the data that have special characteristics, including categories with the greatest, the least, or the same. • ~~Select from among four choices a correct analysis of the data presented in a bar or line graph. For example, given a line graph showing the number of soccer players (in millions) in the U.S. over the time period 1980 to 2000 in five-year intervals, select the correct answer response that relates to the graphs, such as, "The greatest increase in number of soccer players occurred between 1985 and 1990."~~

4.14 The student will collect, organize, display, and interpret data from a variety of graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
categories, and total number of responses) should be written.		

Students entering grades 4 and 5 have had opportunities to identify patterns within the context of the school curriculum and in their daily lives, and they can make predictions about them. They have had opportunities to use informal language to describe the changes within a pattern and to compare two patterns. Students have also begun to work with the concept of a variable by describing mathematical relationships in open number sentences~~, and they have begun to solve simple equations with one unknown~~.

The focus of instruction is to help students develop a solid use of patterning as a problem solving tool. At this level, patterns are represented and modeled in a variety of ways, including numeric, geometric, ~~graphic,~~ and algebraic formats. Students develop strategies for organizing information more easily to understand various types of patterns and functional relationships. They ~~analyze~~ interpret the structure of patterns by exploring and describing patterns that involve change, and they begin to generalize these patterns. By ~~analyzing~~ interpreting mathematical situations and models, students begin to represent these, using symbols and variables to write "rules" for patterns, to describe relationships and algebraic properties, and to represent unknown quantities.

4.15 The student will recognize, create, and extend numerical and geometric patterns.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Most patterning activities should involve some form of concrete materials to make up a pattern. – Students will identify and extend a wide variety of patterns, including rhythmic, geometric, graphic, numerical, and algebraic. The patterns will include both growing and repeating patterns. • Reproduction of a given pattern in a different representation, using symbols and objects, lays the foundation for writing the relationship symbolically or algebraically. • Tables of values should be analyzed for a pattern to determine ~~what element comes next~~ the next value.	**All students should** • Understand that patterns and functions can be represented in many ways and described using words, tables, graphs, and symbols.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe geometric and numerical patterns, using tables, symbols, or words. • Create geometric and numerical patterns, using concrete materials, number lines, tables, and words. • Extend geometric and numerical patterns, using concrete materials, number lines, tables, and words.

4.16 The student will

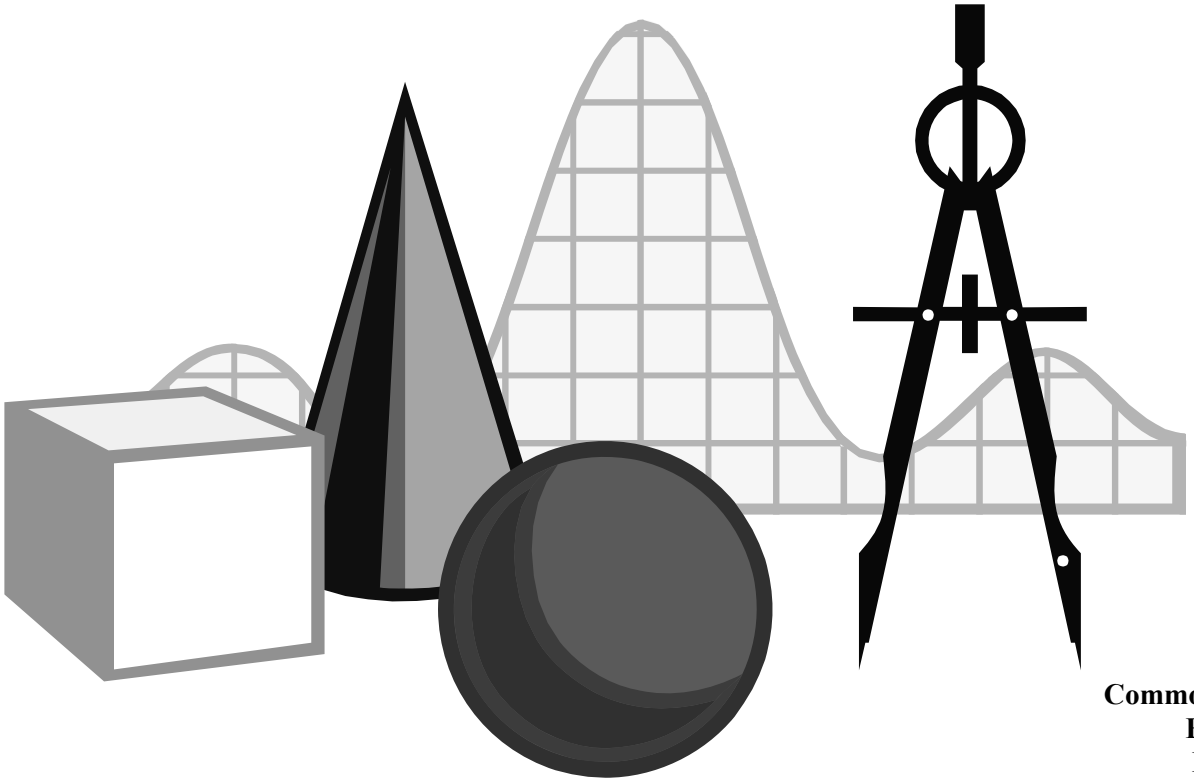
a) recognize and demonstrate the meaning of equality in an equation; and

b) investigate and describe the associative property for addition and multiplication.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Investigating arithmetic operations with whole numbers helps students learn about several different properties of arithmetic relationships. These relationships remain true regardless of the numbers. • The commutative property for addition states that changing the order of the addends does not affect the sum (e.g., 4 + 3 = 3 + 4). Similarly, the commutative property for multiplication states that changing the order of the factors does not affect the product (e.g., 2 × 3 = 3 × 2). • The associative property for addition states that the sum stays the same when the grouping of addends is changed [e.g., 15 + (35 + 16) = (15 + 35) + 16]. The associative property for multiplication states that the product stays the same when the grouping of factors is changed [e.g., 6 × (3 × 5) = (6 × 3) × 5].	**All students should** • Understand that mathematical relationships can be expressed using equations. • Understand that quantities on both sides of an equation must be equal. • Understand that the associative property for addition means you can change the groupings of three or more addends without changing the sum. • Understand that the associative property for multiplication means you can change the groupings of three or more factors without changing the product.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize and demonstrate that the equals sign (=) relates equivalent quantities in an equation. • Write ~~number sentences~~ an equation to represent equivalent mathematical relationships (e.g., 4 × 3 = 2 × 6). • ~~Identify number sentences~~ Recognize and demonstrate ~~that show~~ appropriate use of the equals sign in an equation. • Investigate and describe the associative property for addition as (6 + 2) + 3= 6 + (2 + 3). • Investigate and describe the associative property for multiplication as (3 x 2) x 4 = 3 x (2 x 4).

MATHEMATICS STANDARDS OF LEARNING CURRICULUM FRAMEWORK

Grade 5



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The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

Mathematics instruction in grades 4 and 5 should continue to foster the development of number sense, especially with decimals and fractions. Students with good number sense understand the meaning of numbers, develop multiple relationships and representations among numbers, and recognize the relative magnitude of numbers. They should learn the relative effect of operating on whole numbers, fractions, and decimals and learn how to use mathematical symbols and language to represent problem situations. Number and operation sense continues to be the cornerstone of the curriculum.

The focus of instruction at grades 4 and 5 allows students to investigate and develop an understanding of number sense by modeling numbers, using different representations (e.g., physical materials, diagrams, mathematical symbols, and word names). Students should develop strategies for reading, writing, and judging the size of whole numbers, fractions, and decimals by comparing them, using a variety of models and benchmarks as referents (e.g., $\frac{1}{2}$ or 0.5). Students should apply their knowledge of number and number sense to investigate and solve problems.

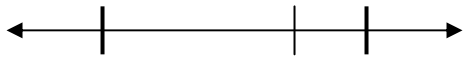
5.1 The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The structure of the ~~b~~Base-10 number system is based upon a simple pattern of tens in which each place is ten times the value of the place to its right. This is known as a ten-to-one place value relationship. • A decimal point separates the whole number places from the places less than one. Place values extend infinitely in two directions from a decimal point. A number containing a decimal point is called a *decimal number* or simply a *decimal*. • To read decimals, – read the whole number to the left of the decimal point, if there is one; – read the decimal point as "and"; – read the digits to the right of the decimal point just as you would read a whole number; and – say the name of the place value of the digit in the smallest place. • Decimals may be written in a variety of forms: – Standard: 23.456 – Written: Twenty-three and four hundred fifty-six thousandths – Expanded: $(2 \times 10) + (3 \times 1) + (4 \times 0.1) + (5 \times 0.01) + (6 \times 0.001)$ • To help students identify the ten-to-one place value relationship for decimals through thousandths, use ~~b~~Base-10 manipulatives, such as place value mats/charts, decimal squares, ~~b~~Base-10 blocks, and money. • Decimals can be rounded to the nearest whole number, tenth or hundredth in situations when exact numbers are not needed.	**All students should** • ~~Understand the place-value structure of decimals and use this structure to read, write, and compare decimals.~~ • Understand that decimals are rounded in a way that is similar to the way whole numbers are rounded. • Understand that decimal numbers can be rounded to ~~an~~ estimate when exact numbers are not needed for the situation at hand.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify the place values for each digit in decimals through thousandths.~~ • ~~Read decimal numbers through thousandths from written words or place-value format.~~ • ~~Write decimal numbers through thousandths from written words or from decimal numbers presented orally.~~ • Round decimal numbers to the nearest whole number, tenth or hundredth. • ~~Identify the symbols for the terms *greater than*, *less than*, and *equal to*.~~ • ~~Compare the value of two decimal numbers through thousandths, using the symbols >, <, or =.~~

5.1 The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~A~~ Strategies for rounding decimal numbers to the nearest whole number, tenth and hundredth ~~is~~ are as follows: – Look one place to the right of the digit to which you wish to round. – If the digit is less than 5, leave the digit in the rounding place as it is, and change the digits to the right of the rounding place to zero. – If the digit is 5 or greater, add 1 to the digit in the rounding place and change the digits to the right of the rounding place to zero. ~~– If the digit is 5 or greater, add 1 to the digit in the rounding place and change the digits to the right of the rounding place to zero.~~ ~~• A procedure for comparing two decimals by examining place value may include the following:~~ ~~– Line up the decimal numbers at their decimal points.~~ ~~– Beginning at the left, find the first place value where the digits are different.~~ ~~– Compare the digits in this place value to determine which number is greater (or which is less).~~ ~~– Use the appropriate symbol > or < or the words *greater than* or *less than* to compare the numbers in the order in which they are presented.~~ ~~– If both numbers are the same, use the symbol = or words *equal to*.~~ ~~Two numbers can be compared by examining place value and/or using a number line.~~ • Create a number line that shows the decimal that is to be rounded.		

5.1 The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The position of the decimal will help children conceptualize the number's placement relative for rounding. An example is to round 5.747 to the nearest hundredth:  5.74 5.747 5.75		

5.2 The student will

a) recognize and name fractions in their equivalent decimal form and vice versa; and

b) compare and order fractions and decimals in a given set from least to greatest and greatest to least.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Students should recognize, name, and focus on finding equivalent decimals of familiar fractions such as halves, fourths, fifths, eighths, and tenths. • Students should be able to determine equivalent relationships between decimals and fractions with denominators up to 12. • Students should have experience with fractions such as $\frac{1}{8}$, whose decimal representation is a terminating decimal (e. g., $\frac{1}{8} = 0.125$) and with fractions such as $\frac{2}{9}$, whose decimal representation does not end but continues to repeat (e. g., $\frac{2}{9} = 0.222\ldots$). The repeating decimal can be written with ellipses (three dots) as in 0.222… or denoted with a bar above the digits that repeat as in $0.\overline{2}$. • To help students compare the value of two decimals through thousandths, use manipulatives, such as place value mats/charts, 10-by-10 grids, decimal squares, ~~b~~Base-10 blocks, meter sticks, number lines, and money. • ~~A procedure for comparing two decimals by examining may include the following:~~ ~~- Line up the decimal numbers at their decimal points.~~	**All students should** • Understand the relationship between ~~commonly used~~ fractions and their decimal form and vice versa. • Understand that fractions and decimals can be compared and ordered from least to greatest and greatest to least.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Represent fractions (halves, fourths, fifths, eighths, ~~and~~ tenths, and twelfths) in their equivalent decimal form and vice versa. • ~~Represent decimals in their equivalent fraction form (halves, fourths, fifths, eighths, and tenths).~~ • ~~Determine~~ Recognize and name equivalent relationships between decimals and fractions with denominators up to 12. • ~~Order~~ Compare and order from least to greatest and greatest to least a given set of no more than five numbers written as decimals, ~~and as~~ fractions, and mixed numbers with denominators of 12 or less.

5.2 The student will

a) recognize and name fractions in their equivalent decimal form and vice versa; and

b) compare and order fractions and decimals in a given set from least to greatest and greatest to least.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~- Beginning at the left, find the first place value where the digits are different.~~ ~~- Compare the digits in this place value to determine which number is greater (or which is less).~~ ~~- Use the appropriate symbol > or < or the words *greater than* or *less than* to compare the numbers in the order in which they are presented.~~ ~~- If both numbers are the same, use the symbol = or words *equal to*.~~ ~~Two numbers can be compared by examining place value and/or using a number line.~~ • Decimals and fractions represent the same relationships; however, they are presented in two different formats. Decimal numbers are another way of writing fractions. Base-10 models (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, money) concretely relate fractions to decimals and vice versa.		

5.3 The student will

a) identify and describe the characteristics of prime and composite numbers; and

b) identify and describe the characteristics of even and odd numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A prime number is a natural number that has exactly two different factors, one and the number itself. • A composite number is a natural number that has more than two different factors. • The number 1 is neither prime nor composite because it has only one factor, itself. • The prime factorization of a number is a representation of the number as the product of its prime factors. For example, the prime factorization of 18 is $2 \times 3 \times 3$. • Prime factorization concepts can be developed by using factor trees. • ~~Zero is not a natural number. Although it has an infinite number of factors, it is neither prime nor composite.~~ • Prime or composite numbers can be represented by rectangular models or rectangular arrays on grid paper. A prime number can be represented by only one rectangular array (e.g., 7 can ~~only~~ be represented by a 7×1 and a 1 x 7). A composite number can always be represented by more than ~~one~~ two rectangular arrays (e.g., 9 can be represented by a 9×1, a 1 x 9, or a 3×3). • Divisibility rules are useful tools in identifying prime and composite numbers. • Students should use manipulatives (e.g., Base-10 blocks, cubes, tiles, hundreds board, etc.) to explore and categorize numbers into groups of	**All students should** • Understand and use the unique characteristics of certain sets of numbers, including prime, composite, even, and odd numbers.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify ~~which numbers are~~ prime ~~for~~ numbers less than or equal to ~~50~~ 100. • Identify ~~which numbers are~~ composite ~~for~~ numbers less than or equal to ~~50~~ 100. • Explain orally and in writing why a number is prime or composite. • Identify which numbers are even or odd. • Explain and demonstrate with manipulatives, pictorial representations, oral language, or written language why a number is even or odd.

5.3 The student will

a) identify and describe the characteristics of prime and composite numbers; and

b) identify and describe the characteristics of even and odd numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
odd or even. • Students should use rules to categorize numbers into groups of odd or even. Rules can include: – An odd number does *not* have 2 as a factor or is *not* divisible by 2. – The sum of two even numbers is even. – The sum of two odd numbers is even. – The sum of an even and an odd is odd. – Even numbers have an even number or zero in the ones place. – Odd numbers have an odd number in the ones place. – An even number has 2 as a factor or is divisible by 2.		

Computation and estimation in grades 4 and 5 should focus on developing fluency in multiplication and division with whole numbers and should begin to extend students' understanding of these operations to work~~ing~~ with ~~fractions and~~ decimals. Instruction should focus on computation activities that enable students to model, explain, and develop ~~reasonable~~ proficiency with basic facts and algorithms. These proficiencies are often developed as a result of investigations and opportunities to develop algorithms. Additionally, opportunities to develop and use visual models, benchmarks, and equivalents, to add and subtract with common fractions, and to develop computational procedures for the addition and subtraction of decimals are a priority for instruction in these grades.

Students should develop an understanding of how whole numbers, fractions, and decimals are written and modeled; an understanding of the meaning of multiplication and division, including multiple representations (e.g., multiplication as repeated addition or as an array); an ability not only to identify but to use relationships between operations to solve problems (e.g., multiplication as the inverse of division); and the ability to use (not identify) properties of operations to solve problems [e.g., 7×28 is equivalent to $(7 \times 20) + (7 \times 8)$~~, or $(7 \times 30) - (7 \times 2)$~~].

Students should develop computational estimation strategies based on an understanding of number concepts, properties, and relationships. Practice should include estimation of sums and differences of common fractions and decimals, using benchmarks (e.g., $\frac{2}{5} + \frac{1}{3}$ must be less than 1 because both fractions are less than $\frac{1}{2}$). Using estimation, students should develop strategies to recognize the reasonableness of their computations. Additionally, students should enhance their ability to select an appropriate problem solving method from among estimation, mental mathematics, paper-and-pencil algorithms, and the use of calculators and computers. With activities that challenge students to use this knowledge and these skills to solve problems in many contexts, students develop the foundation to ensure success and achievement in higher mathematics.

5.4 The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division with and without remainders of whole numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• An example of an approach to solving problems is Polya's four-step plan: – Understand: Retell the problem; read it twice; take notes; study the charts or diagrams; look up words and symbols that are new. – Plan: Decide what operation(s) to use and what sequence of steps to use to solve the problem. – Solve: Follow the plan and work accurately. If the first attempt doesn't work, try another plan. – Look back: Does the answer make sense? • Estimation gives a rough idea of an amount. Strategies such as front-end, rounding, and mental computation may be used to estimate addition, subtraction, multiplication, and division of whole numbers. • Examples of problems to be solved by using estimation strategies are encountered in shopping for groceries, buying school supplies, budgeting allowance, and sharing the cost of a pizza or the prize money from a contest. • Estimation can be used to check the reasonableness of the results. • ~~Terms used in multiplication are~~ ~~*factor* → 376~~ ~~*factor* → × 23~~ ~~*product* → 8,648~~	**All students should** • Understand the meaning of mathematical operations and how these operations relate to one another when creating and solving single-step and multistep word problems.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Select appropriate methods and tools from among paper and pencil, estimation, mental computation, and calculators according to the context and nature of the computation in order to compute with whole numbers. • Create single-step and multistep problems involving the operations of addition, subtraction, multiplication, and~~/or~~ division with and without remainders of whole numbers, using ~~real-life~~ practical situations. • Estimate the sum, difference, product, and quotient of whole number computations. • Solve single-step and multistep problems involving addition, subtraction, multiplication, and division with and without remainders of whole numbers, using paper and pencil, mental computation, and calculators in which – sums, differences, and products will not exceed five digits; – multipliers will not exceed two digits; – divisors will not exceed two digits; or – dividends will not exceed four digits. • Use two or more operational steps to solve a multistep problem. Operations can be the same or different.

5.5 The student will

a) find the sum, difference, product, and quotient of two numbers expressed as decimals through thousandths (divisors with only one nonzero digit); and

b) create and solve single-step and multistep practical problems involving decimals.

UNDERSTANDING THE STANDARD
(Background Information for Instructor Use Only)

- Addition and subtraction ~~with~~ of decimals may be investigated using a variety of models (e.g., 10-by-10 grids, number lines, money).
- Decimal computation uses similar procedures as those developed for whole number computation and applies them to decimal place values, giving careful attention to the placement of the decimal point in the solution.
- Multiplication of decimals follows the same procedure as multiplication of whole numbers. The only difference is that a decimal point must be correctly placed in the product giving careful attention to the placement of the decimal point in the solution.
- The product of decimals is dependent upon the two factors being multiplied.

~~Factors~~		~~Products~~
~~tenths × tenths~~	~~=~~	~~hundredths~~
~~tenths × hundredths~~	~~=~~	~~thousandths~~
~~hundredths × hundredths~~	~~=~~	~~ten-thousandths~~
~~tenths × thousandths~~	~~=~~	~~ten-thousandths~~

- In cases where an exact product is not required, the product of decimals can be estimated using strategies for multiplying whole numbers, such as front-end and compatible numbers, or rounding. In each case, the student needs to determine where to place the decimal point to ensure that the product is reasonable.
- Division is the operation of making equal groups

ESSENTIAL UNDERSTANDINGS

All students should

- Use similar procedures as those developed for whole number computation and apply them to decimal place values, giving careful attention to the placement of the decimal point in the solution.
- Select appropriate methods and tools from among paper and pencil, estimation, mental computation, and calculators according to the context and nature of the computation in order to compute with decimal numbers.
- Understand the various meanings of *division* and its effect on whole numbers.
- Understand various representations of division, i.e.,

$$dividend \div divisor = quotient$$

$$\begin{array}{r} quotient \\ divisor\ \overline{)\,dividend} \end{array}$$

$$\frac{dividend}{divisor} = quotient.$$

ESSENTIAL KNOWLEDGE AND SKILLS

The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to

- Determine an appropriate method of calculation to find the sum, difference, ~~and~~ product, and quotient of two numbers expressed as decimals through thousandths, selecting from among paper and pencil, estimation, mental computation, and calculators.
- Estimate to find the number that is closest to the sum, difference, and product of two numbers expressed as decimals through thousandths.
- Find the sum, difference, and product of two numbers expressed as decimals through thousandths, using paper and pencil, estimation, mental computation, and calculators.
- Determine the quotient, given a dividend expressed as a decimal through thousandths (and no ~~annexing~~ adding of zeros to the dividend during the division process) and a single-digit divisor. ~~All dividends should be evenly divisible by the divisor.~~ For example, 5.4 divided by 2 and 5.4 divided by 6.
- ~~Find the sum, difference, and product of two numbers expressed as decimals through thousandths, using mental computation.~~
- ~~Find the sum, difference, and product of two numbers expressed as decimals through thousandths, using calculators.~~
- Use estimation to check the reasonableness of a sum, difference, ~~and~~ product, and quotient.

5.5 The student will

a) find the sum, difference, product, and quotient of two numbers expressed as decimals through thousandths (divisors with only one nonzero digit); and

b) create and solve single-step and multistep practical problems involving decimals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
or shares. When the original amount and the number of shares are known, divide to find the size of each share. When the original amount and the size of each share are known, divide to find the number of shares. Both situations may be modeled with ~~b~~Base-10 manipulatives. • The fair-share concept of decimal division can be modeled, using manipulatives (e.g., ~~b~~Base-10 blocks). • Division ~~of~~ with decimals is performed the same way as division of whole numbers. The only difference is the placement of the decimal point in the quotient. • The quotient can be estimated, given a dividend expressed as a decimal through thousandths (and no ~~annexing~~ ~~of~~ adding of zeros to the dividend during the division process) and a single-digit divisor. • Estimation can be used to check the reasonableness of a quotient. • Division is the inverse of multiplication; therefore, multiplication and division are inverse operations. • Terms used in division are *dividend, divisor*, and *quotient.* dividend ÷ divisor = quotient quotient divisor)dividend • There are a variety of algorithms for division such		• Create and solve single-step and multistep problems. • A multistep problem needs to incorporate two or more operational steps (operations can be the same or different).

5.5 The student will

a) find the sum, difference, product, and quotient of two numbers expressed as decimals through thousandths (divisors with only one nonzero digit); and

b) create and solve single-step and multistep practical problems involving decimals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
as repeated multiplication and subtraction. Experience with these algorithms may enhance understanding of the traditional long division algorithm. • A multistep problem needs to incorporate no more than two operational steps (operations can be the same or different).		

5.6 The student will solve single-step and multistep practical problems involving addition and subtraction with fractions and mixed numbers and express answers in simplest form.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A fraction can be expressed in simplest form (simplest equivalent fraction) by dividing the numerator and denominator by their greatest common factor. • ~~A fraction is in simplest form when its~~ When the numerator and denominator have no common factors other than 1~~.~~, then the fraction is in simplest form. • Fractions having like denominators means the same as fractions having common denominators. • Equivalent fractions name the same amount. To find equivalent fractions, multiply or divide the numerator and denominator by the same nonzero number. • Addition and subtraction with fractions and mixed numbers can be modeled using a variety of concrete materials and pictorial representations as well as paper and pencil. • To add, subtract, and compare fractions and mixed numbers, it often helps to find the least common denominator. The least common denominator (LCD) of two or more fractions is the least common multiple (LCM) of the denominators. • To add or subtract with fractions having the same or like denominators, add or subtract the numerators and write in simplest form. • To add or subtract with fractions that do not have the same denominator, first find equivalent fractions with the least common denominator. Then add or subtract and write the answer in	**All students should** • Develop and use strategies to estimate and compute addition and subtraction of fractions. • Understand the concept of least common multiple and least common denominator as they are important when adding and subtracting fractions. • Understand that a fraction is in simplest form when its numerator and denominator have no common factors other than 1. The numerator can be greater than the denominator.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Add and subtract~~ Solve single-step and multistep practical problems involving addition and subtraction with fractions having like and unlike denominators. Denominators in the problems should be limited to 12 or less (e.g.; $\frac{1}{5} + \frac{1}{4}$) and answers should be expressed in simplest form. • ~~Add and subtract~~ Solve single-step and multistep practical problems involving addition and subtraction with mixed numbers having like and unlike denominators, with and without regrouping. Denominators in the problems should be limited to 12 or less, and answers should be expressed in simplest form. • Use estimation to check the reasonableness of a sum or difference.

5.6 The student will solve single-step and multistep practical problems involving addition and subtraction with fractions and mixed numbers and express answers in simplest form.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
simplest form. • A mixed number has two parts: a whole number and a fraction. The value of a mixed number is the sum of its two parts. • To add or subtract with mixed numbers, students may use a number line, draw a picture, rewrite fractions with like denominators, or rewrite mixed numbers as fractions.		

5.7 The student will evaluate whole number numerical expressions, using the order of operations limited to parentheses, addition, subtraction, multiplication, and division.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• An expression, like a phrase, has no equal sign. • Expressions are simplified by using the order of operations. • The order of operations defines the computation order to follow in simplifying an expression. • The order of operations is as follows: – First, complete all operations within grouping symbols. If there are grouping symbols within other grouping symbols, do the innermost operation first. – Second, evaluate all exponential expressions. – Third, multiply and/or divide in order from left to right. – Fourth, add and/or subtract in order from left to right.	**All students should** • Understand that the order of operations describes the order to use to simplify expressions containing more than one operation. • ~~Select appropriate strategies and tools to simplify expressions.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Simplify expressions by using the order of operations in a demonstrated step-by-step approach. • Find the value of numerical expressions, using the order of operations~~, mental mathematics, and appropriate tools. Exponents are limited to positive values. Fractions are limited to having denominators of 12 or less. Decimals are limited to the thousandth place~~. • Given an expression involving more than one operation, describe which operation is completed first, which is second, etc.

Students in grades 4 and 5 should be actively involved in measurement activities that require a dynamic interaction among students and their environment. Students can see the usefulness of measurement if classroom experiences focus on measuring objects and estimating measurements. Textbook experiences cannot substitute for activities that utilize measurement to answer questions about real problems.

The approximate nature of measurement deserves repeated attention at this level. It is important to begin to establish some benchmarks by which to estimate or judge the size of objects. ~~The intent is for students to make "ballpark" comparisons and *not* to memorize conversion factors between U.S. Customary and metric units. To fully understand these ballpark comparisons, students must be actively engaged in the process of measurement.~~

Students use standard and nonstandard, age-appropriate tools to measure objects. Students also use age-appropriate language of mathematics to verbalize the measurements of length, weight/mass, liquid volume, area, temperature, and time.

The focus of instruction should be an active exploration of the real world in order to apply concepts from the two systems of measurement (metric and U.S. Customary), to measure perimeter, weight/mass, liquid volume/capacity, area, temperature, and time. Students continue to enhance their understanding of measurement by using appropriate tools such as rulers, balances, clocks, and thermometers. The process of measuring is identical for any attribute (i.e., length, weight/mass, liquid volume/capacity, area): choose a unit, compare that unit to the object, and report the number of units.

5.8 The student will

a) find perimeter, area, and volume in standard units of measure;
b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;
c) identify equivalent measurements within the metric system;
d) estimate and then measure to solve problems, using U.S. Customary and metric units; and
e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Perimeter is the distance around an object. It is a measure of length. Area is the number of square units needed to cover a surface. Volume is a measure of capacity~~.~~ and is measured in cubic units. • To find the perimeter of any polygon, add the lengths of the sides. • Students should label the perimeter ~~or~~, area, and volume with the appropriate unit of linear ~~or~~, square or cubic measure. • Area is the number of square units needed to cover a surface or figure. • ~~Students should investigate the area of a square, rectangle, and triangle by using manipulatives (e.g., tiles, geoboards, graph paper).~~ • Students should investigate, using manipulatives, to discover the formulas for the area of a square, rectangle, and right triangle; and volume of a rectangular solid. – Area of a rectangle = Length × Width – Area of a square = Side × Side – Area of a right triangle = $\frac{1}{2}$ Base × Height – Volume of a rectangular solid = Length x Width x Height	**All students should** • Understand the concepts of perimeter, ~~and~~ area, and volume. • Understand and use appropriate units of measure for perimeter, ~~and~~ area, and volume. • Understand the difference between using perimeter, area, and volume in a given situation. • Understand how to select a measuring device and unit of measure to solve problems involving measurement.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine the perimeter of a polygon, with or without diagrams, when – the lengths of all sides of a polygon that is not a rectangle or a square are given; – the length and width of a rectangle are given; or – the length of a side of a square is given. • Estimate and determine the perimeter of a polygon, and area of a square, rectangle, and right triangle following the parameters listed above, using only whole number measurements given in metric or U.S. Customary units, and record the solution with the appropriate unit of measure (e.g., 24 square inches). • Estimate and determine the area of a square, with or without diagrams, when the length of a side is given. • Estimate and determine the area of a rectangle, with or without diagrams, when the length and width are given. • Estimate and determine the area of a right triangle, with or without diagrams, when the base and the height are given. • Differentiate ~~between~~ among the concepts of area, perimeter, and volume.

5.8 The student will

a) find perimeter, area, and volume in standard units of measure;
b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;
c) identify equivalent measurements within the metric system;
d) estimate and then measure to solve problems, using U.S. Customary and metric units; and
e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Length is the distance along a line or figure from one point to another. • U.S. Customary units for measurement of length include inches, feet, yards, and miles. Appropriate measuring devices include rulers, yardsticks, and tape measures. Metric units for measurement of length include millimeters, centimeters, meters, and kilometers. Appropriate measuring devices include centimeter rulers, meter sticks, and tape~~s~~ measures. • When measuring with U.S. Customary units, students should be able to measure to the nearest part of an inch ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$), foot, or yard~~, or mile~~. • Weight and mass are different. Mass is the amount of matter in an object. Weight is determined by the pull of gravity on the mass of an object. The mass of an object remains the same regardless of its location. The weight that an object changes is dependent on the gravitational pull at its location. In everyday life, most people are actually interested in determining an object's mass, although they use the term *weight* (e.g., "How much does it weigh?" versus "What is its mass?"). • Appropriate measuring devices to measure mass in U.S. Customary units (ounces, pounds) and metric units (grams, kilograms) are balances.		• Describe ~~real-life~~ practical situations where area, perimeter, and volume are appropriate measures to use, and justify their choices orally or in writing. • Identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation. • Develop a procedure for finding the volume of a rectangular solid. • Determine the volume of a rectangular solid using manipulatives (e.g., cubes) or pictorial representations. • Solve problems involving measurement by selecting an appropriate measuring device and a U.S. Customary or metric unit of measure for the following: – length: part of an inch ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$), inches, feet, yards, ~~miles,~~ millimeters, centimeters, meters, and kilometers; – weight: ounces, pounds, and tons; – mass: grams and kilograms; – liquid volume: cups, pints, quarts, gallons, milliliters, and liters; – area: square units; and – temperature: Celsius and Fahrenheit units. • Estimate the conversion of Celsius and Fahrenheit units relative to familiar situations: – Water freezes at 0°C and 32°F. – Water boils at 100°C and 212°F.

5.8 The student will

a) find perimeter, area, and volume in standard units of measure;
b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;
c) identify equivalent measurements within the metric system;
d) estimate and then measure to solve problems, using U.S. Customary and metric units; and
e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• U.S. Customary units to measure liquid volume (capacity) include cups, pints, quarts, and gallons. Metric units to measure liquid volume (capacity) include milliliters and liters. • Temperature is measured using a thermometer. The U.S. Customary unit of measure is degrees Fahrenheit; the metric unit of measure is degrees Celsius. • Practical experience measuring familiar objects helps students establish benchmarks and facilitates students' ability to use the units of measure to make estimates.		– Normal body temperature is about 37°C and 98.6°F.

5.9 The student will identify and describe the diameter, radius, chord, and circumference of a circle.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A circle is a set of points on a flat surface (plane) with every point equidistant from a given point called the *center*. • A chord is a line segment connecting any two points on a circle. Students will benefit from understanding that a chord goes from one side of the circle to the other, but does not need to pass through the center. • A diameter is a chord that goes through the center of a circle. The diameter is two times the radius. A radius is a segment from the center of a circle to any point on the circle. Two radii end-to-end form a diameter of a circle. • Circumference is the distance around or perimeter of a circle. The circumference is about 3 times larger than the diameter of a circle.	**All students should** • ~~Identify the parts of a circle.~~ • Understand that a chord is a line segment that extends between any two unique points of a circle. ~~The diameter is also a special chord that goes through the center of a circle.~~ • Understand that a diameter is also a special chord that goes through the center of a circle. • ~~Understand that a diameter is a line segment that goes through the center of the circle.~~ • Understand the relationship between the measures of diameter and radius and the relationship between the measures of radius and circumference. • Understand that a radius is a line segment that extends between the center and the circumference of the circle. • Understand that the circumference is the distance around the circle. Perimeter is the measure of the circumference.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify and describe the diameter, radius, chord, and circumference of a circle. • Describe the relationship between – diameter and radius~~; and~~, – diameter and chord; ~~and~~ – radius and circumference; and~~.~~ – diameter and circumference. • ~~Identify the diameter, radius, chord, and circumference of a given circle.~~ • The length of the diameter of a circle is twice the length of the radius.

5.10 The student will determine an amount of elapsed time in hours and minutes within a 24-hour period.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Elapsed time is the amount of time that has passed between two given times. • Elapsed time can be found by counting on from the beginning time to the finishing time. – Count the number of whole hours between the beginning time and the finishing time. – Count the remaining minutes. – Add the hours and minutes. For example, to find the elapsed time between 10:15 a.m. and 1:25 p.m., count on as follows: – from 10:15 a.m. to 1:15 p.m., count 3 hours; – from 1:15 p.m. to 1:25 p.m., count 10 minutes; and then – add 3 hours to 10 minutes to find the total elapsed time of 3 hours and 10 minutes.	**All students should** • Understand that elapsed time can be found by counting on from the beginning time to the finishing time.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine elapsed time in hours and minutes within a 24-hour period.

5.11 The student will measure right, acute, obtuse, and straight angles.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Angles are measured in degrees. There are up to 360 degrees in an angle. A degree is $\frac{1}{360}$ of a complete rotation of a full circle. There are 360 degrees in a circle. • To measure the number of degrees in an angle, use a protractor or an angle ruler. • A right angle measures exactly 90°. • An acute angle measures less than 90°. • An obtuse angle measures greater than 90° but less than 180°. • A straight angle measures exactly 180°. • Before measuring an angle, students should first compare it to a right angle to determine whether the measure of the angle is less than or greater than 90°. • Students should understand how to work with a protractor or angle ruler as well as available computer software to measure and draw angles and triangles. • ~~A right triangle has one right angle.~~ • ~~An obtuse triangle has one obtuse angle and two acute angles.~~ • ~~An acute triangle has three acute angles.~~	**All students should** • Understand how to measure ~~and draw~~ acute, right, ~~and~~ obtuse, and straight angles. • ~~Understand how to identify a triangle as either acute, right, or obtuse.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the appropriate tools (e.g., protractor and straightedge or angle ruler as well as available software) used to measure and draw angles and triangles. • ~~Draw right, acute, and obtuse angles, using appropriate tools.~~ • Measure right, acute, straight, and obtuse angles, using appropriate tools, and identify their measures in degrees. • ~~Measure the angles of right, acute, and obtuse triangles, using appropriate tools, and identify their measures in degrees.~~

The study of geometry helps students represent and make sense of the world. At the fourth- and fifth-grade levels, reasoning skills typically grow rapidly, and these skills enable students to investigate geometric problems of increasing complexity and to study how geometric terms relate to geometric properties. Students develop knowledge about how geometric ~~shapes~~ figures relate to each other and begin to use mathematical reasoning to analyze and justify properties and relationships among ~~shapes~~ figures.

Students discover these relationships by constructing, drawing, measuring, comparing, and classifying geometric ~~shapes~~ figures. Investigations should include explorations with everyday objects and other physical materials. Exercises that ask students to visualize, draw, and compare ~~shapes~~ figures will help them not only to develop an understanding of the relationships, but to develop their spatial sense as well. ~~Discussing ideas, conjecturing, and testing hypotheses precede the development of more formal summary statements.~~ In the process, definitions become meaningful, relationships among figures are understood, and students are prepared to use these ideas to develop informal arguments.

Students investigate, identify, and draw representations and describe the relationships between and among points, lines, line segments, rays, and angles. Students apply generalizations about lines, angles, and triangles to develop understanding about congruence, other lines such as parallel and perpendicular ones, and classifications of triangles. ~~Students also explore coordinate geometry, using the coordinate plane to describe points in the first quadrant.~~

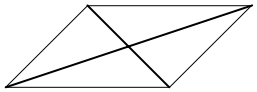
The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.)
- **Level 3: Abstraction.** Definitions are meaningful, with relationships being perceived between properties and between figures. Logical implications and class inclusions are understood, but the role and significance of deduction is not understood. (Students should transition to this level during grades 5 and 6 and fully attain it before taking ~~A~~algebra.)

5.12 The student will classify
a) angles as right, acute, obtuse, or straight; and
b) triangles as right, acute, obtuse, equilateral, scalene, or isosceles.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A right angle ~~is an angle that forms a square corner. A right angle~~ measures exactly 90°. • ~~An acute angle forms an angle less than a right angle.~~ An acute angle measures greater than 0° but less than 90°. • ~~An obtuse angle forms an angle greater than a right angle.~~ An obtuse angle measures greater than 90° but less than 180°. • A straight angle forms an angle that measures exactly 180°. • A right triangle has one right angle. • An obtuse triangle has one obtuse angle. • An acute triangle has three acute angles (or no angle measuring 90° or greater). • A scalene triangle has no congruent sides. • An isosceles triangle has two congruent sides. • To facilitate the exploration of relationships, ask students whether a right triangle can have an obtuse angle. Why or why not? Can an obtuse triangle have more than one obtuse angle? Why or why not? What type of angles are the two angles other than the right angle in a right triangle? What type of angles are the two angles other than the obtuse angle in an obtuse triangle?	**All students should** • Understand that ~~triangles~~ angles can be classified ~~by the measures of their angles.~~ as right, acute, obtuse, or straight according to their measures. • Understand ~~how to identify~~ that a triangle can be classified as either ~~acute,~~ right, acute, or obtuse according to the measure of its largest angle. • Understand that a triangle can be classified as equilateral, scalene, or isosceles according to the number of sides with equal length.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Classify angles as right, acute, straight, ~~and~~ or obtuse. • Classify triangles as right, acute, ~~and~~ or obtuse. • Classify triangles as equilateral, scalene, or isosceles.

5.13 The student, using plane figures (square, rectangle, triangle, parallelogram, rhombus, and trapezoid), will
a) develop definitions of these plane figures; and
b) investigate and describe the results of combining and subdividing plane figures.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A triangle is a polygon with three sides. Triangles may be classified according to the measure of their angles, i.e., right, acute, or obtuse. Triangles may also be classified according to the measure of their sides, i.e., scalene (no sides congruent), isosceles (at least two sides congruent) and equilateral (all sides congruent). • A quadrilateral is a polygon with four sides. • A parallelogram is a quadrilateral in which both pairs of opposite sides are parallel. Properties of a parallelogram include the following: – A diagonal (a segment that connects two vertices of a polygon but is not a side) divides the parallelogram into two congruent triangles. – The opposite sides of a parallelogram are congruent. – The opposite angles of a parallelogram are congruent. – The diagonals of a parallelogram bisect each other. To bisect means to cut a geometric figure into two congruent halves. A bisector is a line segment, line, or plane that divides a geometric figure into two congruent halves. A sample of a bisected parallelogram is below. 	**All students should** • ~~Understand that the defining properties and symmetry of various plane figures are unique.~~ • Understand that simple plane figures can be combined to make more complicated figures and that complicated figures can be subdivided into simple plane figures.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections and representation to** • ~~Recognize and identify the properties of~~ Develop definitions for squares, rectangles, triangles, parallelograms, rhombi, ~~kites~~ and trapezoids. • ~~Describe the properties of squares, rectangles, triangles, parallelograms, rhombi, kites and trapezoids.~~ • ~~Analyze the properties of squares, rectangles, triangles, parallelograms, rhombi, kites and trapezoids.~~ • ~~Identify congruent, non-congruent, and similar figures~~. • Investigate and ~~Describe~~ describe the results of combining and subdividing ~~shapes~~ plane figures. • ~~Identify and describe a line of symmetry.~~ • ~~Recognize the images of figures resulting from geometric transformations such as translation, reflection, or rotation.~~

5.13 The student, using plane figures (square, rectangle, triangle, parallelogram, rhombus, and trapezoid), will
a) develop definitions of these plane figures; and
b) investigate and describe the results of combining and subdividing plane figures.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A rectangle is a parallelogram with four right angles. Since a rectangle is a parallelogram, a rectangle has the same properties as those of a parallelogram. • A square is a rectangle with four congruent sides. Since a square is a rectangle, a square has all the properties of a rectangle and of a parallelogram. • A rhombus is a parallelogram with four congruent sides. Opposite angles of a rhombus are congruent. Since a rhombus is a parallelogram, the rhombus has all the properties of a parallelogram. • A trapezoid is a quadrilateral with exactly one pair of parallel sides. The parallel sides are called *bases,* and the nonparallel sides are called *legs*. If the legs have the same length, then the trapezoid is an isosceles trapezoid. • ~~A kite is a quadrilateral with two distinct pairs of adjacent congruent sides.~~ • Two or more figures can be combined to form a new ~~shape~~ figure. Students should be able to identify the figures that have been combined. • The region of ~~A~~ a polygon may be subdivided into two or more regions that represent figures. Students should understand how to divide the region of a polygon into familiar figures.		

Students entering grades 4 and 5 have explored the concepts of chance and are able to determine possible outcomes of given events. Students have utilized a variety of random generator tools, including random number generators (number cubes), spinners, and two-sided counters. In game situations, students are able to predict whether the game is fair or not fair. Furthermore, students are able to identify events as likely or unlikely to happen. Thus the focus of instruction at grades 4 and 5 is to deepen their understanding of the concepts of probability by

- ~~developing the continuum of terms to include *impossible*, *unlikely*, *equally likely*, *possible*, and *certain*;~~
- offering opportunities to set up models simulating ~~real-life~~ practical events;
- engaging students in activities to enhance their understanding of fairness; and
- engaging students in activities ~~imbued~~ that instill ~~with~~ a spirit of investigation and exploration and providing students with opportunities to use manipulatives.

The focus of statistics instruction is to assist students with further development and investigation of data collection strategies. Students should continue to focus on

- posing questions;
- collecting data and organizing this data into meaningful graphs, charts, and diagrams based on issues relating to ~~real-world~~ practical experiences;
- interpreting the data presented by these graphs;
- answering descriptive questions (“How many?” “How much?”) from the data displays;
- identifying and justifying comparisons (“Which is the most? Which is the least?” “Which is the same? Which is different?”) about the information;
- comparing their initial predictions to the actual results; and
- writing a few sentences to communicate to others their ~~analysis and~~ interpretation of the data.

Through a study of probability and statistics, students develop a real appreciation of data analysis methods as powerful means for decision making.

5.14 The student will make predictions and determine the probability of an outcome by constructing a sample space.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Probability is the chance of an event occurring. • The probability of an event occurring is the ratio of desired outcomes to the total number of possible outcomes. If all the outcomes of an event are equally likely to occur, the probability of the event = number of favorable outcomes / total number of possible outcomes. • The probability of an event occurring is represented by a ratio between 0 and 1. An event is "impossible" if it has a probability of 0 (e.g., the probability that the month of April will have 31 days). An event is "certain" if it has a probability of 1 (e.g., the probability that the sun will rise tomorrow morning). • When a probability experiment has very few trials, the results can be misleading. The more times an experiment is done, the closer the experimental probability comes to the theoretical probability (e.g., a coin lands heads up half of the time). • Students should have opportunities to describe in informal terms (i.e., *impossible*, *unlikely*, *as likely as unlikely*, *as likely as*, *equally likely*, *likely*, and *certain*) the degree of likelihood of an event occurring. Activities should include ~~real-life~~ practical examples. • For any event such as flipping a coin, the equally likely things that can happen are called *outcomes*. For example, there are two equally likely outcomes when flipping a coin: the coin can land heads up, or the coin can land tails up. • A sample space represents all possible outcomes of an experiment. The sample space may be organized in a list, chart, or tree diagram. • Tree diagrams ~~are drawn to~~ show all ~~of the~~ possible	**All students should** • Understand ~~and apply~~ that the basic concepts of probability can be applied to make predictions of outcomes of simple experiments. • Understand that a sample space represents all possible outcomes of an experiment. • ~~Understand that the measure of the likelihood of an event can be represented by a number from 0 to 1.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Construct a sample space, using a tree diagram to identify all possible outcomes of a single event ~~an outcome~~. • Construct a sample space, using a list or chart to represent all possible outcomes of a single event. • ~~Determine~~ Predict and determine the probability of ~~a single event~~ an outcome by constructing a sample space. The sample space ~~when the~~ will have a total ~~number~~ of ~~12~~ 24 or less possible outcomes ~~is 12 or less~~. • ~~Create a problem statement involving probability based on information from a given problem situation. Students will not be expected to solve the problem.~~

5.14 The student will make predictions and determine the probability of an outcome by constructing a sample space.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~combinations (~~outcomes~~)~~ in a sample space. The Fundamental ~~c~~Counting ~~p~~Principle ~~tells~~ describes how to find the number of outcomes when there~~ is more than one way to put things together~~ are multiple choices. For example, how many different outfit combinations can you make from 2 shirts (red and blue) and 3 pants (black, white, khaki)? The sample space displayed in a tree diagram would show that there are $2 \times 3 = 6$ (~~counting principle~~ Fundamental Counting Principle) outfit combinations: red-black; red-white; red-khaki; blue-black; blue-white; blue-khaki. • A spinner with eight equal-sized sections is equally likely to land on any one of the sections, three of which are red, three green, and two yellow. Have students write a problem statement involving probability, such as, "What is the probability that the spinner will land on green?"		

5.15 The student, given a problem situation, will collect, organize, and interpret data in a variety of forms, using stem-and-leaf plots and line graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The emphasis in all work with statistics should be on the analysis and the communication of the analysis, rather than on a single correct answer. Data analysis should include opportunities to describe the data, recognize patterns or trends, and make predictions. • Statistical investigations should be active, with students formulating questions about something in their environment and finding quantitative ways to answer the questions. • Investigations can be brief class surveys or more extended projects taking many days. • Through experiences displaying data in a variety of graphical representations, students learn to select an appropriate representation. • ~~Bar graphs are used to compare counts of different categories (categorical data).~~ ~~– A bar graph uses either horizontal or vertical bars to represent counts for several categories. One bar is used for each category, with the length of the bar representing the count for that category.~~ ~~– There is space before, between, and after the bars.~~ ~~– The axis displaying the scale representing the count for the categories should extend one increment above the greatest recorded piece of data. Fifth-grade students should collect data that is recorded in increments of multiples of whole numbers, decimals, and fractions.~~ ~~– Each axis should be labeled, and the graph should have a title.~~	**All students should** • ~~Understand that bar graphs compare categorical data, stem-and-leaf plots list data in a meaningful array, and line graphs show changes over time.~~ • Understand how to interpret ~~propose and justify conclusions and predictions that are based on~~ ~~displays of~~ collected and organized data. • Understand that ~~bar graphs compare categorical data,~~ stem-and-leaf plots list data in a meaningful array~~,~~ ~~and line graphs show changes over time~~. It helps in finding median, modes, minimum and maximum values, and ranges. • Understand that line graphs show changes over time.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Formulate the question that will guide the data collection. • Collect data, using observations (e.g., weather), measurement (e.g., shoe sizes), surveys (e.g., ~~favorite television shows~~ hours watching television), or experiments (e.g., plant growth). • Organize the data into a chart, ~~or~~ table, stem-and-leaf plots and line graphs. • ~~Construct bar graphs, labeling one axis with equal whole number or decimal increments and the other axis with attributes of the topic (categorical data) (e.g., skiing, basketball, ice hockey, skating, and sledding as the categories of "Favorite Winter Sports"). Bar graphs will have no more than six categories.~~ • Display data in line graphs~~, bar graphs,~~ and stem-and-leaf plots. • Construct line graphs, labeling the vertical axis with equal whole number, decimal, or fractional increments and the horizontal axis with continuous data commonly related to time (e.g., hours, days, months, years, and age). Line graphs will have no more than six identified points along a continuum for continuous data (e.g., the decades: 1950s, 1960s, 1970s, 1980s, 1990s, and 2000s). • Construct a stem-and-leaf plot to organize and display data, where the stem is listed in ascending order and the leaves are in ascending order, with or without commas between leaves. • Title the given graph or identify the title.

5.15 The student, given a problem situation, will collect, organize, and interpret data in a variety of forms, using stem-and-leaf plots and line graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
– ~~Statements representing an analysis and interpretation of the characteristics of the data (e.g., similarities and differences, mode, and least and greatest) in the graph should be included.~~ • Line graphs are used to show how two continuous variables are related. Line graphs ~~are~~ may be used to show how one variable changes over time. If one variable is not continuous, then a broken line is used. By looking at a ~~single~~ line graph, it can be determined whether the variable is increasing, decreasing, or staying the same over time. – The values along the horizontal axis represent continuous data on a given variable, usually some measure of time (e.g., time in years, months, or days). The data presented on a line graph is referred to as "continuous data" because it represents data collected over a continuous period of time. – The values along the vertical axis are the scale and represent the frequency with which those values occur in the data set. The values should represent equal increments of multiples of whole numbers, fractions, or decimals depending upon the data being collected. The scale should extend one increment above the greatest recorded piece of data. – Each axis should be labeled and the graph should have a title. – A line graph tells whether something has increased, decreased, or stayed the same with the passage of time. Statements representing an analysis and interpretation		• Interpret the data ~~to compare the answer to the prediction~~ in a variety of forms (e.g., orally or in written form.) • ~~Write a few sentences to describe the interpretation of the data.~~

5.15 The student, given a problem situation, will collect, organize, and interpret data in a variety of forms, using stem-and-leaf plots and line graphs.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
of the characteristics of the data in the graph should be included (e.g., trends of increase and/or decrease, and least and greatest). A broken line is used if the data collected is not continuous data (such as test scores); a solid line is used if the data is continuous (such as height of a plant). • Stem-and-leaf plots allow the exact values of data to be listed in a meaningful array. Data covering a range of 25 numbers are best displayed in a stem-and-leaf plot and are utilized to organize numerical data from least to greatest, using the digits of the greatest to group data. – The data is organized from least to greatest. – Each value should be separated into a stem and a leaf [e.g., two-digit numbers are separated into stems (tens) and leaves (ones)]. – The stems are listed vertically from least to greatest with a line to their right. The leaves are listed horizontally, also from least to greatest, and can be separated by spaces or commas. Every value is recorded regardless of the number of repeats. – A key is often included to explain how to read the plot.		

5.16 The student will

a) describe mean, median, and mode as measures of center;
b) describe mean as fair share;
c) find the mean, median, mode, and range of a set of data; and
d) describe the range of a set of data as a measure of variation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Statistics is the science of conducting studies to collect, organize, summarize, analyze, and draw conclusions from data. • A measure of center is a value at the center or middle of a data set. Mean, median, and mode are measures of center. • The mean, median, and mode are three of the various ways that data can be analyzed. • ~~The mean is the numerical average of the data set and is found by adding all the values in the set and dividing the sum by the number of values.~~ Mean represents a fair share concept of the data. Dividing the data constitutes a fair share. This is done by equally dividing the data points. This should be demonstrated visually and with manipulatives. The arithmetic way is to add all of the data points then divide by the number of data points to determine the average or mean. • The median is the piece of data that lies in the middle of the set of data arranged in order. • The mode is the piece of data that occurs most frequently in the data set. There may be one, more than one, or no mode in a data set. Students should order the data from least to greatest so they can better find the mode. • The range is the spread of a set of data. The range of a set of data is the difference between the greatest and least values in the data set. It is	**All students should** • Understand that mean, median, and mode are described as measures of center. • Understand that mean, median, and mode are three of the various ways that data can be ~~measured~~ described or summarized. • Understand that mean as fair share is described as equally dividing the data set or the data set has already been divided equally. • ~~Understand that the mean is the numerical average of a data set; the median is the number in the middle of a set of data; the mode is the piece of data that occurs most often; and the range is the spread of a set of data.~~ • Understand how to ~~determine~~ find the mean, median, and mode~~, and range~~ of a set of data as measures of center. • Understand ~~what the number tells them about the data, and they need to see those~~ values in the context of other characteristics of the data in order to best describe ~~or analyze~~ the results.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Calculate~~ Describe and find the mean of a group of numbers representing data from a given context as a measure of center. • ~~Determine~~ Describe and find the median of a group of numbers representing data from a given context as a measure of center. • ~~Determine~~ Describe and find the mode of a group of numbers representing data from a given context as a measure of center. • Describe mean as fair share. • ~~Determine~~ Describe and find the range of a group of numbers representing data from a given context as a measure of variation.

5.16 The student will

a) describe mean, median, and mode as measures of center;
b) describe mean as fair share;
c) find the mean, median, mode, and range of a set of data; and
d) describe the range of a set of data as a measure of variation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
determined by subtracting the s~~mallest~~ least number in the data set from the ~~largest~~ greatest number in the data set. An example is ordering test scores from least to greatest: 73, 77, 84, 87, 89, 91, 94. The greatest score in the data set is 94 and the least score is 73, so the least score is subtracted from the greatest score or 94 - 73 = 21. The range of these test scores is 21. • Students need to learn more than how to identify the mean, median, mode, and range of a set of data. They need to build an understanding of what the number tells them about the data, and they need to see those values in the context of other characteristics of the data in order to best describe ~~or analyze~~ the results.		

Students entering grades 4 and 5 have had opportunities to identify patterns within the context of the school curriculum and in their daily lives, and they can make predictions about them. They have had opportunities to use informal language to describe the changes within a pattern and to compare two patterns. Students have also begun to work with the concept of a variable by describing mathematical relationships in open number sentences. ~~and they have begun to solve simple equations with one unknown.~~

The focus of instruction is to help students develop a solid use of patterning as a problem solving tool. At this level, patterns are represented and modeled in a variety of ways, including numeric, geometric, ~~graphic~~ and algebraic formats. Students develop strategies for organizing information more easily to understand various types of patterns and functional relationships. They ~~analyze~~ interpret the structure of patterns by exploring and describing patterns that involve change, and they begin to generalize these patterns. By ~~analyzing~~ interpreting mathematical situations and models, students begin to represent these, using symbols and variables to write "rules" for patterns, to describe relationships and algebraic properties, and to represent unknown quantities.

5.17 The student will describe the relationship found in a number pattern and express the relationship.

UNDERSTANDING THE STANDARD
(Background Information for Instructor Use Only)

- There are an infinite number of patterns.
- The simplest types of patterns are repeating patterns. In such patterns, students need to identify the basic unit of the pattern and repeat it.
- Growing patterns are more difficult for students to understand than repeating patterns because not only must they determine what comes next, they must also begin the process of generalization. Students need experiences with growing patterns ~~in both a numerical and geometric formats~~.
- Sample numerical patterns are
  6, 9, 12, 15, 18, …;
  5, 7, 9, 11, 13, …;
  1, 2, 4, 7, 11, 16, …;
  2, 4, 8, 16, 32, …; ~~and~~
  32, 30, 28, 26, 24…; and
  1, 5, 25, 125, 625, ….
- An expression, like a phrase, has no equal sign.
- When the pattern data are graphed in a T-table, an expression can represent that data. An example is:

X	Y
6	9
7	10
11	14
15	18

This example defines the relationship as $x + 3$.

- ~~In geometric patterns, students must often recognize transformations of a figure, particularly rotation or reflection. Rotation (turn) is the result~~

ESSENTIAL UNDERSTANDINGS

All students should

- Understand that patterns and functions can be represented in many ways and described using words, tables, ~~graphs,~~ and symbols.
- Understand the structure of a pattern and how it grows or changes using concrete materials and calculators.
- Understand that mathematical relationships exist in patterns.
- Understand that an expression uses symbols to define a relationship and shows how each number in the list, after the first number, is related to the preceding number.
- Understand that expressions can be numerical or variable or a combination of numbers and variables.

ESSENTIAL KNOWLEDGE AND SKILLS

The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to

- Describe numerical and geometric patterns formed by using concrete materials and calculators.
- ~~Express~~ Describe the relationship found in ~~numerical and geometric~~ patterns, using words, tables, ~~graphs, or a mathematical sentence~~ and symbols to express the relationship.

5.17 The student will describe the relationship found in a number pattern and express the relationship.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~of turning a figure around a point or a vertex, and reflection (flip) is the result of flipping a figure over a line.~~ • Expressions are simplified by using the order of operations. • A verbal quantitative expression involving one operation can be represented by a variable expression that describes what is going on. Numbers are used when they are known; variables are used when the numbers are unknown. For example, "a full box of cookies and four extra" can be represented by $b + 4$; "three full boxes of cookies" by $3b$; "a full box of cookies shared among four" by $\frac{b}{4}$. • A mathematical expression contains a variable or a combination of variables, numbers, and/or operation symbols and represents a mathematical relationship. An expression cannot be solved.		

5.18 The student will

a) investigate and describe the concept of variable;
b) write an open sentence to represent a given mathematical relationship, using a variable;
c) model one-step linear equations in one variable, using addition and subtraction; and
d) create a problem situation based on a given open sentence, using a single variable.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A variable is a symbol that can stand for an~~y~~ ~~one of a~~ unknown ~~set of~~ number~~s~~ or ~~other~~ object~~s~~. • ~~A variable is a quantity that can have different values. Any letter can be used as a variable.~~ • A variable expression is like a phrase: as a phrase does not have a verb, so an expression does not have an equals sign (=). • A verbal ~~quantitative~~ expression involving one operation can be represented by a variable expression that describes what is going on. Numbers are used when they are known; variables are used when the numbers are unknown. For example, "a full box of cookies and four extra" can be represented by $b + 4$; "three full boxes of cookies" by $3b$; "a full box of cookies shared among four" by $\frac{b}{4}$. • An open sentence ~~is a mathematical sentence~~ contains~~ing~~ a variable and an equals sign (=). For example, the sentence, "A full box of cookies and four extra equal 24 cookies." can be written as $b + 4 = 24$, where b stands for the number of cookies in one full box. "Three full boxes of cookies equal 60 cookies." can be written as $3b = 60$. • ~~An~~ Another example of an open sentence is ~~a mathematical sentence containing a variable. It also contains an equals sign (=). For example~~, $b + 3 = 23$ and represents the answer to the word problem, "How many cookies are in a box if the box plus three	**All students should** • Understand that a variable is a symbol that can stand for ~~any member of a set of numbers~~ an unknown number or object. • Understand that a variable expression is a variable or combination of variables, numbers, and symbols that represents a mathematical relationship. • Understand that verbal ~~quantitative~~ expressions can be translated to variable expressions. • Understand that an open sentence has ~~is a mathematical sentence with~~ a variable and an equal sign (=). • Understand that problem situations can be expressed as open sentences.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe the concept of a variable (presented as boxes, letters, or other symbols) as a representation of an unknown quantity. • ~~Use a variable expression to represent a given verbal expression involving one operation (e.g., "5 more than a number" can be represented by $x + 5$).~~ • Write an open sentence with addition, subtraction, multiplication, or division, using a variable to represent a missing number. • Create and write a word problem to match a given open sentence with a single variable and one operation.

5.18 The student will

a) investigate and describe the concept of variable;
b) write an open sentence to represent a given mathematical relationship, using a variable;
c) model one-step linear equations in one variable, using addition and subtraction; and
d) create a problem situation based on a given open sentence, using a single variable.

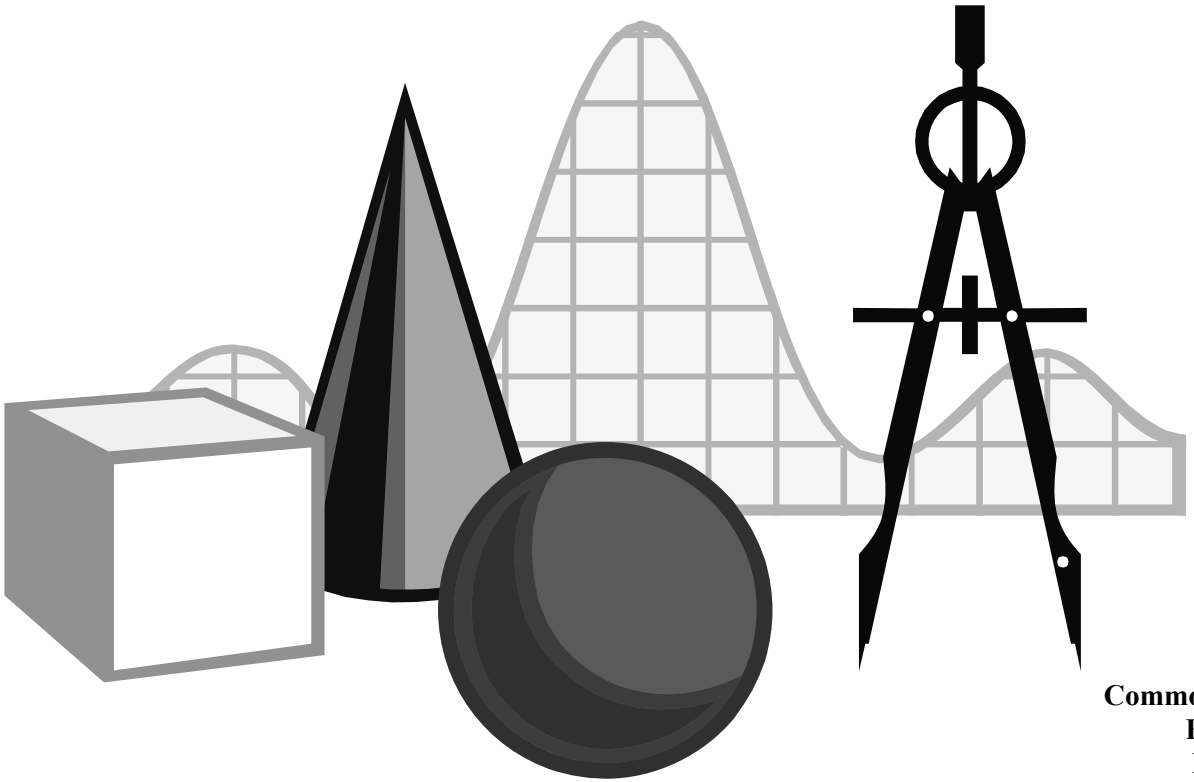
UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
more equals 23 cookies, where *b* stands for the number of cookies in the box? • At this level, discuss how the symbol × used to represent multiplication can often be confused with the variable *x*. Students can minimize this confusion by using parentheses [e.g., 4(*x*) = 20 or 4x = 20] or a small dot raised off the line to represent multiplication [4 • x = 20]. • By using story problems and numerical sentences, students begin to explore forming equations and representing quantities using variables. • An open sentence containing a variable is neither true nor false until the variable is replaced with a number.		

5.19 The student will investigate and recognize the distributive property of multiplication over addition.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The distributive property states that multiplying a sum by a number gives the same result as multiplying each addend by the number and then adding the products (e.g., 3(4 + 5) = 3 x 4 + 3 x 5, 5 x (3 + 7) = (5 x 3) + (5 x 7); or (2 x 3) + (2 x 5) = 2 x (3 + 5). • The distributive property can be used to simplify expressions (e.g., 9 x 23 = 9(20+3) =180+ 27 = 207; or 5 x 19 = 5(10 + 9) = 50 + 45 = 95).	**All students should** • Understand that the distributive property states that multiplying a sum by a number gives the same result as multiplying each addend by the number and then adding the products. • Understand that using the distributive property with whole numbers helps with understanding mathematical relationships. • Understand when and why the distributive property is used.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Investigate and recognize the distributive property of whole numbers, limited to multiplication over addition using diagrams and manipulatives. • Investigate and recognize an equation that represents the distributive property, when given several whole number equations, limited to multiplication over addition.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Grade 6



Commonwealth of Virginia
Board of Education
Richmond, Virginia
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NOTICE TO THE READER

The Virginia Department of Education does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities.

The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students in the middle grades focus on mastering rational numbers. Rational numbers play a critical role in the development of proportional reasoning and advanced mathematical thinking. The study of rational numbers builds on the understanding of whole numbers, fractions, and decimals developed by students in the elementary grades. Proportional reasoning is the key to making connections to most middle school mathematics topics.
- Students develop an understanding of integers and rational numbers by using concrete, pictorial, and abstract representations. They learn how to use equivalent representations of fractions, decimals, and percents and recognize the advantages and disadvantages of each type of representation. Flexible thinking about rational number representations is encouraged when students solve problems.
- Students develop an understanding of the properties of operations on real numbers through experiences with rational numbers and by applying the order of operations.
- Students use a variety of concrete, pictorial, and abstract representations to develop proportional reasoning skills. Ratios and proportions are a major focus of mathematics learning in the middle grades.

6.1 The student will describe and compare data, using ratios, and will use appropriate notations, such as $\frac{a}{b}$, *a* to *b*, and *a*:*b*.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A ratio is a comparison of any two quantities ~~and conveys an idea that cannot be expressed as a single number~~. A ratio is used to represent ~~a variety of~~ relationships within ~~a set~~ and between ~~two~~ sets. • A ratio can compare part of a set to the entire set (part-whole comparison). • A ratio can compare part of a set to another part of the same set (part-part comparison). • A ratio can compare part of a set to a corresponding part of another set (part-part comparison). • A ratio can compare all of a set to all of another set (whole-whole comparison). • The order of the quantities in a ratio is directly related to the order of the quantities expressed in the relationship. For example, if asked for the ratio of the number of cats to dogs in a park, the ratio must be expressed as the number of cats to the number of dogs, in that order. • A ratio is a multiplicative comparison of two numbers, measures, or quantities. • All fractions are ratios and vice versa. • Ratios may or may not be written in simplest form. • Ratios can compare two parts of a whole. • Rates can be expressed as ratios.	~~**All students should**~~ • ~~Understand that a ratio is a comparison of two quantities.~~ • ~~Understand that ratios can be represented in more than one way.~~ • What is a ratio? A ratio is a comparison of any two quantities. A ratio is used to represent relationships within a set and between two sets. A ratio can be written using ~~a~~ fraction form ($\frac{2}{3}$), a colon (2:3), or the word *to* (2 to 3).	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe a relationship within a set by comparing part of the set to the entire set. • Describe a relationship between two sets by comparing part of one set to a corresponding part of the other set. • Describe a relationship between two sets by comparing all of one set to all of the other set. • Describe a relationship within a set by comparing one part of the set to another part of the same set. • Represent ~~the~~ a ~~verbal~~ relationship in words that makes a comparison by using the notations $\frac{a}{b}$, *a*:*b*, and *a to b*. • Create a relationship in words for a given ratio expressed symbolically.

6.1 The student will describe and compare data, using ratios, and will use appropriate notations, such as $\frac{a}{b}$, *a* to *b*, and *a*:*b*.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/		

6.2 The student will

a) investigate and describe fractions, decimals and percents as ratios;
b) identify a given fraction, decimal or percent from a representation;
c) demonstrate equivalent relationships among fractions, decimals, and percents; and
d) compare and order fractions, decimals, and percents.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• *Percent* means "per 100" or how many "out of 100"; *percent* is another name for *hundredths*. • A number followed by a percent symbol (%) is equivalent to that number with a denominator of 100 (e.g., $30\% = \frac{30}{100} = \frac{3}{10} = 0.3$). • Percents can be expressed as fractions with a denominator of 100 (e.g., $75\% = \frac{75}{100} = \frac{3}{4}$). • Percents can be expressed as decimal (e.g., $38\% = \frac{38}{100} = 0.38$). • ~~A~~ Some fractions can be rewritten as ~~an~~ equivalent fractions with ~~a~~ denominators of ~~100~~ powers of 10, and~~, thus~~, ~~as a~~ can be represented as decimals or percents (e.g., $\frac{3}{5} = \frac{6}{10} = \frac{60}{100} = 0.60 = 60\%$). • Decimals, fractions, and percents can be represented using concrete materials (e.g., ~~b~~Base-10 blocks, number lines, decimal squares, or grid paper). • Percents ~~should~~ can be represented by drawing ~~a~~ shaded regions on ~~a 10-by-10~~ grids or by finding a location on number lines ~~to represent a given percents~~. • Percents are used in real life for taxes, sales, data description, and data comparison.	~~All students should~~ • ~~Understand that percent is a way of representing fractions and decimals.~~ • ~~Understand that a number can be written as a fraction, decimal, or percent.~~ • ~~Understand that percent is a method of standardization that is efficient because each number is always based on 100ths hundredths.~~ • ~~Understand that percents are used in real life applications to compare or describe data.~~ • What is the relationship among fractions, decimals and percents? Fractions, decimals, and percents are three different ways to express the same number. A ratio can be written using ~~a~~ fraction form ($\frac{2}{3}$), a colon (2:3), or the word *to* (2 to 3). Any number that can be written as a fraction can be expressed as a terminating or repeating decimal or a percent.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Recognize that *percent* means "out of 100" or *hundredths*, using the percent symbol (%).~~ • Identify the decimal and percent equivalents for ~~halves, thirds, fourths, fifths, and tenths~~ numbers written in fraction form including repeating decimals. • Represent fractions, decimals, and percents on a number line. • Describe orally and in writing the equivalent relationships among decimals, percents, and fractions that have denominators that are factors of 100. • ~~Draw a shaded region on a 10-by-10 grid to represent a given fraction, decimal, and percent~~. • Represent, by shading a grid, a fraction, decimal, and percent. • Represent in ~~decimal,~~ fraction, decimal, and~~/or~~ percent form a given shaded region of a ~~10-by-10~~ grid. • Compare two decimals through thousandths ~~by representing the decimals with decimal~~ using manipulatives ~~or~~, ~~picture~~ pictorial representations, ~~or by using place-value charts~~ number lines, ~~or~~ and

6.2 The student will

a) investigate and describe fractions, decimals and percents as ratios;
b) identify a given fraction, decimal or percent from a representation;
c) demonstrate equivalent relationships among fractions, decimals, and percents; and
d) compare and order fractions, decimals, and percents.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Fractions, decimals and percents are equivalent forms representing a given number. • The decimal point is a symbol that ~~indicates the location of the ones place and all other subsequent in the decimal system~~separates the whole number part from the fractional part of a number. • The decimal point separates the whole number amount from the part of a number that is less than one. • The symbol • can be used in Grade 6 in place of X to indicate multiplication. • ~~Decimals can be represented and compared, using decimal manipulatives, drawings, pictures, or symbols.~~ • ~~Fractions can be represented and compared by using fraction manipulatives, drawings, pictures, or symbols.~~ • Strategies using 0, $\frac{1}{2}$ and 1 as benchmarks can be used to compare fractions. • When comparing two fractions, use $\frac{1}{2}$ as a benchmark. Example: Which is greater, $\frac{4}{7}$ or $\frac{3}{9}$?		~~the~~ symbols (<, ≤, ≥, .>, ~~or~~ =). • ~~Compare two whole numbers by representing the numbers with concrete objects or picture representations or by using the symbols <, ≤, >, ≥, or =.~~ • Compare two fractions with denominators of 12 or less ~~by representing the fractions with fraction~~ using manipulatives ~~or picture~~ , pictorial representations, number lines, ~~or by using the~~ and symbols (<, ≤, ≥, .>, ~~or~~ =). • Compare two percents using pictorial representations and symbols (<, ≤, ≥, .>, =). • Order no more than 3 fractions, decimals, and~~/or~~ percents (decimals through thousandths, fractions with denominators of 12 or less), in ascending or descending order.

6.2 The student will

a) investigate and describe fractions, decimals and percents as ratios;
b) identify a given fraction, decimal or percent from a representation;
c) demonstrate equivalent relationships among fractions, decimals, and percents; and
d) compare and order fractions, decimals, and percents.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
$\frac{4}{7}$ is greater than $\frac{1}{2}$ because 4, the numerator, represents more than half of 7, the denominator. The denominator tells the number of parts that make the whole. $\frac{3}{9}$ is less than $\frac{1}{2}$ because 3, the numerator, is less than half of 9, the denominator, which tells the number of parts that make the whole. Therefore, $\frac{4}{7} > \frac{3}{9}$. • When comparing two fractions close to 1, use distance from 1 as your benchmark. Example: Which is greater, $\frac{6}{7}$ *or* $\frac{8}{9}$? $\frac{6}{7}$ is $\frac{1}{7}$ away from 1 whole. $\frac{8}{9}$ *is* $\frac{1}{9}$ away from 1 whole. Since $\frac{1}{7} > \frac{1}{9}$, then $\frac{6}{7}$ is a greater distance away from 1 whole than $\frac{8}{9}$ so $\frac{8}{9} > \frac{6}{7}$. • Students should have experience with fractions such as $\frac{1}{8}$, whose decimal representation is a terminating		

6.2 The student will

a) investigate and describe fractions, decimals and percents as ratios;
b) identify a given fraction, decimal or percent from a representation;
c) demonstrate equivalent relationships among fractions, decimals, and percents; and
d) compare and order fractions, decimals, and percents.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
decimal (e. g., $\frac{1}{8}$ = 0.125) and with fractions such as $\frac{2}{9}$, whose decimal representation does not end but continues to repeat (e. g., $\frac{2}{9}$ = 0.222…). The repeating decimal can be written with ellipses (three dots) as in 0.222… or denoted with a bar above the digits that repeat as in $0.\overline{2}$. Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/ under computation and estimation.		

6.3 The student will

a) identify and represent integers;
b) order and compare integers; and
c) identify and describe absolute value of integers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Integers are the set of whole numbers, ~~and~~ their opposites, and zero. • Positive integers are greater than zero. • Negative integers are less than zero. • Zero is an integer that is neither positive nor negative. • A negative integer is always less than a positive integer. • When comparing two negative ~~numbers~~ integers, the negative ~~number~~ integer that is closer to zero is greater. • An integer and its opposite are the same distance from zero on a number line. For example, the opposite of 3 is -3. • The absolute value of a number is the distance of a number from zero on the number line regardless of direction. Absolute value is represented as $\lvert -6 \rvert = 6$. • On a conventional number line, a smaller number is always located to the left of a larger number (e.g., -7 lies to the left of -3, thus $-7 < -3$; 5 lies to the left of 8 thus 5 is less than 8).	~~All students should~~ • ~~Understand how to identify, represent, order, and compare integers.~~ • What role do negative integers play in practical situations? Some examples of the use of negative integers are found in temperature (below 0), finance (owing money), below sea level. There are many other examples. • How does the absolute value of an integer compare to the absolute value of its opposite? They are the same because an integer and its opposite are the same distance from zero on a number line.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify an integer represented by a point on a number line. • Represent integers on a number line. • ~~Compare and order~~ Order and compare integers using a number line. • Compare integers, using ~~the~~ mathematical symbols (<, >, ~~and~~ =). • Identify and describe the absolute value of an integer.

6.4 The student will demonstrate multiple representations of multiplication and division of fractions.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Using manipulatives to build conceptual understanding and using pictures and sketches to link concrete examples to the symbolic enhance students' understanding of operations with fractions and help students connect the meaning of whole number computation to fraction computation. • Multiplication and division of fractions can be represented with arrays, paper folding, repeated addition, repeated subtraction, fraction strips, pattern blocks and area models. • When multiplying a whole by a fraction such as 3 x $\frac{1}{2}$, the meaning is the same as with multiplication of whole numbers: 3 groups the size of $\frac{1}{2}$ of the whole. • When multiplying a fraction by a fraction such as $\frac{2}{3} \cdot \frac{3}{4}$, we are asking for part of a part. • When multiplying a fraction by a whole number such as $\frac{1}{2}$ x 6, we are trying to find a part of the whole. • ~~Using an area model assists with students' developing understanding of multiplication and division of fractions.~~ • For measurement division, the divisor is the number of groups. You want to know how many are in each of those groups . Division of fractions can be explained as how many of a given divisor are	• When multiplying fractions, what is the meaning of the operation? When multiplying a whole by a fraction such as 3 x $\frac{1}{2}$, the meaning is the same as with multiplication of whole numbers: 3 groups the size of $\frac{1}{2}$ of the whole. When multiplying a fraction by a fraction such as $\frac{2}{3} \bullet \frac{3}{4}$, we are asking for part of a part. When multiplying a fraction by a whole number such as $\frac{1}{2}$ x 6, we are trying to find a part of the whole. • What does it mean to divide with fractions? For measurement division, the divisor is the number of groups and the quotient will be the number of groups in the dividend. Division of fractions can be explained as how many of a given divisor are needed to equal the given dividend. In other words, for $\frac{1}{4} \div \frac{2}{3}$ the question is, "How many $\frac{2}{3}$ make $\frac{1}{4}$?" For partition division the divisor is the size of the group, so the quotient answers the question, "How much is the whole?" or "How much for one?"	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Demonstrate the concepts of multiplication and division of fractions.~~ • Demonstrate multiplication and division of fractions using multiple representations~~ including, but not limited to, arrays, paper folding, fractions strips, pattern blocks and area models~~. • ~~Discover and then m~~Model algorithms for multiplying and dividing with fractions using appropriate representations.

6.4 The student will demonstrate multiple representations of multiplication and division of fractions.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
needed to equal the given dividend. In other words, for $\frac{1}{4} \div \frac{2}{3}$, the question is, "How many $\frac{2}{3}$ make $\frac{1}{4}$?" • For partition division the divisor is the size of the group, so the quotient answers the question, "How much is the whole?" or "How much for one?" Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#nns		

6.5 The student will investigate and describe concepts of positive exponents and perfect squares.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• In exponential notation, the base is the number that is multiplied, and the exponent represents the number of times the base is used as a factor. In 8^3, 8 is the base and 3 is the exponent. • A power of a number represents repeated multiplication of the number by itself (e.g., $8^3 = 8 \times 8 \times 8$ and is read "8 to the third power"). • Any real number other than zero raised to the zero power is 1. Zero to the zero power (0) is undefined. • ~~Patterns in place-value charts provide visual meaning of exponents: $10^3 = 1000$, $10^2 = 100$, $10^1 = 10$.~~ • Perfect squares are the numbers that result from multiplying any whole number by itself (e.g., $36 = 6 \times 6 = 6^2$). • Perfect squares can be represented geometrically as the areas of squares the length of whose sides are whole numbers (e.g., 1×1, 2×2, or 3×3). This can be modeled with grid paper, tiles, geoboards and virtual manipulatives.	~~**All students should**~~ • ~~Understand that a power of a number is repeated multiplication of that number by itself.~~ • ~~Understand that squaring a number and taking a square root of a number are inverse operations.~~ • What does exponential form represent? Exponential form is a short way to write repeated multiplication of a common factor such as 5 x 5 x 5 x 5 = 5^4. • What is the relationship between perfect squares and a geometric square? A perfect square is the area of a geometric square ~~where~~ whose side length is a whole number.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize and describe patterns with exponents that are natural numbers, by using a calculator. • Recognize and describe patterns of perfect squares not to exceed 20^2, by using grid paper, square tiles, tables, and calculators. • ~~Recognize and describe patterns with square roots and squares by using squares, grid paper, and calculators~~. • Recognize powers of ten by examining patterns in a place value chart: $10^4 = 10{,}000$, $10^3 = 1000$, $10^2 = 100$, $10^1 = 10$, $10^0 = 1$.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop conceptual and algorithmic understanding of operations with integers and rational numbers through concrete activities and discussions that bring meaning to why procedures work and make sense.
- Students develop and refine estimation strategies and develop an understanding of when to use algorithms and when to use calculators. Students learn when exact answers are appropriate and when, as in many life experiences, estimates are equally appropriate.
- Students learn to make sense of the mathematical tools they use by making valid judgments of the reasonableness of answers.
- Students reinforce skills with operations with whole numbers, fractions, and decimals through problem solving and application activities.

6.6 The student will

a) multiply and divide fractions and mixed numbers; and

b) estimate solutions and then solve single-step and multistep practical problems that involving addition, subtraction, multiplication, and division of fractions.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Simplifying fractions to ~~their~~ simplest form assists with uniformity of answers ~~and concepts~~. • ~~Equivalent forms are needed to perform the operations of addition and subtraction with fractions.~~ • Addition and subtraction are inverse operations as are ~~M~~ multiplication and division. ~~are inverse operations.~~ • ~~Rewriting an improper fraction as a mixed numeral assists with uniformity of answers and concepts.~~ • ~~There is implied addition of the whole number part and the fractional part in mixed numerals.~~ • ~~Using manipulatives to build conceptual understanding and using pictures and sketches to link concrete examples to the symbolic enhance students' understanding of operations with fractions and help students connect the meaning of whole number computation to fraction computation.~~ • It is helpful to use estimation to develop computational strategies. For example, $2\frac{7}{8}\cdot\frac{3}{4}$ is about $\frac{3}{4}$ of 3, so the answer is between 2 and 3. • When multiplying a whole by a fraction such as	~~**All students should**~~ • How are multiplication and division of fractions and multiplication and division of whole numbers alike? ~~Understand that f~~ Fraction computation ~~uses the same ideas~~ can be approached in the same way as whole number computation, applying those concepts to fractional parts. • What is the role of estimation in solving problems? ~~Use e~~ Estimation ~~to~~ helps determine the reasonableness of answers.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Simplify fractional answers to simplest form.~~ • Multiply and divide with fractions and mixed numbers. Answers ~~may be~~ are expressed in simplest form. • Solve single and multistep practical problems that involve addition and~~/or~~ subtraction with fractions and mixed numbers, with and without regrouping, that include like and unlike denominators of 12 or less ~~and express answers in simplest form~~. Answers ~~may be~~ are expressed in simplest form. • Solve single and multistep practical problems that involve multiplication and~~/or~~ division with fractions and mixed numbers that include denominators of 12 or less ~~and express answers in simplest form~~. Answers ~~may be~~ are expressed in simplest form.

6.6 The student will

a) multiply and divide fractions and mixed numbers; and

b) estimate solutions and then solve single-step and multistep practical problems that involving addition, subtraction, multiplication, and division of fractions.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
$3 \cdot \frac{1}{2}$, the meaning is the same as with multiplication of whole numbers: 3 groups the size of $\frac{1}{2}$ of the whole. • When multiplying a fraction by a fraction such as $\frac{2}{3} \cdot \frac{3}{4}$, we are asking for part of a part. • When multiplying a fraction by a whole number such as $\frac{1}{2} \cdot 6$, we are trying to find a part of the whole. • ~~It is helpful for students to simplify before they multiply fractions, using the commutative property of multiplication to reduce fractions to simplest form before multiplying.~~		

6.7 The student will solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of decimals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Estimation is an essential skill used to make sense of the placement of the decimal point in performing operations on decimals and for checking the decimal point's correct placement.~~ • Different strategies can be used to estimate the result of computations and judge the reasonableness of the result. For example: What is an approximate answer for 2.19 ÷ 0.8? The answer is around 2 because 2 ÷ 1 = 2. • Understanding the placement of the decimal point is very important when finding quotients of decimals. Examining patterns with successive decimals provides meaning, such as dividing the dividend by 6, by 0.6, by 0.06, and by 0.006. • Solving multistep problems in the context of real-life situations enhances interconnectedness and proficiency with estimation strategies. • Examples of ~~real-life~~ practical situations solved by using estimation strategies include shopping for groceries, buying school supplies, budgeting an allowance, deciding what time to leave for school or the movies, and sharing a pizza or the prize money from a contest. • ~~A consumer application problem is defined as the type of problem that is normally encountered in daily living, such as problems related to money, travel, work, recreation, and home life.~~ • ~~A budget may be kept for short or long periods of~~	~~**All students should**~~ • ~~Be able to produce an approximate answer for a given problem.~~ • ~~Understand that an estimated answer helps validate the reasonableness of a computed answer.~~ • What is the role of estimation in solving problems? Estimation gives a reasonable solution to a problem when an exact answer is not required. If an exact answer is required, estimation allows you to know if the calculated answer is reasonable.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Solve multistep practical problems involving decimals by using estimation strategies and checking for the reasonableness of results.~~ • ~~Given a dividend expressed as a decimal through thousandths and a divisor expressed as a decimal to thousandths with exactly one non-zero digit, find the quotient.~~ • ~~Given a dividend expressed as a decimal through thousandths and a divisor expressed as a decimal to thousandths with more than one non-zero digit, find the quotient by using a calculator.~~ • Solve single-step and multistep practical problems involving addition, subtraction, multiplication and division ~~of~~ with decimals expressed to thousandths with no more than two operations.

6.7 The student will solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of decimals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~time. Students may keep a short-term budget to enable the purchase of an expensive item or a long-term budget to facilitate a long-term spending plan.~~		

6.8 The student will evaluate whole number numerical expressions, using the order of operations.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The order of operations is a convention that defines the computation order to follow in simplifying an expression. • The order of operations is as follows: – First, complete all operations within grouping symbols*. If there are grouping symbols within other grouping symbols, do the innermost operation first. – Second, evaluate all exponential expressions. – Third, multiply and/or divide in order from left to right. – Fourth, add and/or subtract in order from left to right. * ~~Grouping symbols include p~~Parentheses ( ), brackets [ ], braces {}, and the division bar – as in $\frac{3+4}{5+6}$ should be treated as grouping symbols. • The power of a number represents repeated multiplication of the number (e.g., $8^3 = 8 \cdot 8 \cdot 8$). The base is the number that is multiplied, and the exponent represents the number of times the base is used as a factor. In the example, 8 is the base, and 3 is the exponent. • Any number, except 0, raised to the zero power is 1. Zero to the zero power is undefined.	~~**All students should**~~ • What is the significance of the order of operations? ~~Understand that the~~ The order of operations ~~describes~~ prescribes the order to use to simplify expressions containing more than one operation. It ensures that there is only one correct answer.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Simplify expressions by using the order of operations in a demonstrated step-by-step approach. The expressions should be limited to positive values and not include ~~braces~~ parentheses ( ), brackets [ ], braces { }, or absolute value | |. • Find the value of numerical expressions, using order of operations, mental mathematics, and appropriate tools. Exponents are limited to positive values.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop the measurement skills that provide a natural context and connection among many mathematics concepts. Estimation skills are developed in determining length, weight/mass, liquid volume/capacity, and angle measure. Measurement is an essential part of mathematical explorations throughout the school year.
- Students continue to focus on experiences in which they measure objects physically and develop a deep understanding of the concepts and processes of measurement. Physical experiences in measuring various objects and quantities promote the long-term retention and understanding of measurement. Actual measurement activities are used to determine length, weight/mass, and liquid volume/capacity.
- Students examine perimeter, area, and volume, using concrete materials and practical situations. Students focus their study of surface area and volume on rectangular prisms, cylinders, pyramids, and cones.

6.9 The student will make ballpark comparisons between measurements in the U.S. Customary System of measurement and measurements in the metric system.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Making sense of various units of measure is an essential life skill, requiring reasonable estimates of what measurements mean, particularly in relation to other units of measure. – 1 inch is about 2.5 centimeters. – 1 foot is about 30 centimeters. – 1 meter is a little longer than a yard, or about 40 inches. – 1 mile is slightly farther than 1.5 kilometers. – 1 kilometer is slightly farther than half a mile. – 1 ounce is about 28 grams. – 1 nickel has the mass of about 5 grams. – 1 kilogram is a little more than 2 pounds. – 1 quart is a little less than 1 liter. – 1 liter is a little more than 1 quart. – Water freezes at 0°C and 32°F. – Water boils at 100°C and 212°F. – Normal body temperature is about 37°C and 98°F. – Room temperature is about 20°C and 70°F. • ~~Multiple experiences with using nonstandard and standard units of measure to measure physical objects help students develop an intuitive understanding of size.~~ • Mass is the amount of matter in an object. Weight is the pull of gravity on the mass of an object. The mass of an object remains the same regardless of its location. The weight of an object changes dependent on the gravitational pull at its location. In everyday life, most people are actually interested in determining an object's mass, although they use the term *weight*, as shown by the questions: "How much	~~**All students should**~~ • ~~Understand that there is a structured relationship between and among units of measure for length, area, weight/mass, and volume in the metric and U.S. Customary systems.~~ • What is the difference between weight and mass? ~~Understand that w~~ Weight and mass are different. Mass is the amount of matter in an object. Weight is the pull of gravity on the mass of an object. The mass of an object remains the same regardless of its location. The weight of an object changes dependent on the gravitational pull at its location. • ~~Understand that measures are determined by quantitative comparison to a standard unit.~~ • How do you determine which units to use at different times? Units of measure are determined by the attributes of the object being measured. ~~Understand that m~~ Measures of length are expressed in linear units, measures of area are expressed in square units, and measures of volume are expressed in cubic units. • Why are there two different measurement systems? Measurement systems are conventions invented by different cultures to meet their needs. The U.S. Customary System is the preferred method in the United States. The metric system is the preferred system worldwide.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Compare and convert units of measure for length, area, weight/mass, and volume within the U.S. Customary system and the metric system.~~ • Estimate the conversion of units of length, ~~area,~~ weight/mass, ~~and~~ volume, and temperature between the U.S. Customary system and the metric system by using ballpark comparisons. Ex: 1 L ≈ 1qt. Ex: 4L ≈ 4 qts. • ~~Determine the most appropriate unit of measure for a given situation.~~ • Estimate measurements by comparing the object to be measured against a benchmark. • ~~Solve measurement problems by estimating and determining length, using standard and nonstandard units of measure.~~ • ~~Solve measurement problems by estimating and determining weight/mass, using standard and nonstandard units of measure~~. • ~~Solve measurement problems by estimating and determining area, using standard and nonstandard units of measure~~. • ~~Solve measurement problems by estimating and determining liquid volume/capacity, using standard and nonstandard units of measure.~~

6.9 The student will make ballpark comparisons between measurements in the U.S. Customary System of measurement and measurements in the metric system.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
does it weigh?" versus "What is its mass?" • ~~Chunking or benchmarks are strategies used to make measurement estimates.~~ • ~~Chunks of length, such as a window's length, can be used to estimate the length of a classroom wall~~. • ~~Benchmarks, such as the two-meter height of a standard doorway, can be used to estimate height.~~ • The degree of accuracy of measurement required is determined by the situation. • Whether to use an underestimate or an overestimate is determined by the situation. • Physically measuring objects along with using visual and symbolic representations improves student understanding of both the concepts and processes of measurement. Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#measurement		

6.10 The student will

a) define pi (π) as the ratio of the circumference of a circle to its diameter;
b) solve practical problems involving circumference and area of a circle, given the diameter or radius;
c) solve practical problems involving area and perimeter; and
d) describe and determine the volume and surface area of a rectangular prism.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Experiences in deriving the formulas for area and perimeter, using manipulatives such as tiles, one-inch cubes, adding machine tape, graph paper, geoboards, or tracing paper, promote an understanding of the formulas and facility in their use. • The perimeter of a polygon is the measure of the distance around the polygon. • Circumference is the distance around or perimeter of a circle. • The area of a closed curve is the number of nonoverlapping square units required to fill the region enclosed by the curve. • The perimeter of a square whose side measures s is 4 times s ($P = 4s$), and its area is side times side ($A = s^2$). • The perimeter of a rectangle is the sum of twice the length and twice the width [$P = 2l + 2w$, or $P = 2(l + w)$], and its area is the product of the length and the width ($A = l \cancel{\times} w$). • ~~Experiences in using a variety of measuring devices and making real measurements promote an understanding of measurements and the formulas associated with measurements.~~ • The value of pi (π) is the ratio of the circumference	~~**All students should**~~ • ~~Understand the attributes of polygons and the use of measures to determine area and perimeter.~~ • ~~Understand the derivation of formulas related to area and perimeter of polygons and how to determine which is used in problem situations.~~ • ~~Select the appropriate approximation for pi (π) when solving problems~~. • ~~Understand the derivation of pi and formulas for finding circumference and area of a circle.~~ • What is the relationship between the circumference and diameter of a circle? The circumference of a circle is about 3 times the measure of the diameter. • What is the difference between area and perimeter? Perimeter is the distance around the outside of a figure while area is the measure of the amount of space enclosed by the perimeter. • What is the relationship between area and surface area? Surface area is calculated for a three-dimensional figure. It is the sum of the areas of the two-dimensional surfaces that make up the three-dimensional figure.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Derive an approximation for pi (3.14 or $\frac{22}{7}$) by gathering data and comparing the circumference to the diameter of various circles, using concrete materials or computer models. • Find the circumference of a circle by substituting a value for the diameter or the radius into the formula $C = \pi d$ or $C = 2\pi r$. • Find the area of a circle by using the formula $A = \pi r^2$. • Apply formulas to solve practical problems involving area and perimeter of triangles and rectangles. • Create and solve problems that involve finding the circumference and~~/or~~ area of a circle when given the diameter or radius. • Solve problems that require finding the surface area of a rectangular prism, given a diagram of the prism with the necessary dimensions labeled. • Solve problems that require finding the volume of a rectangular prism given a diagram of the prism with the necessary dimensions labeled.

6.10 The student will

a) define pi (π) as the ratio of the circumference of a circle to its diameter;
b) solve practical problems involving circumference and area of a circle, given the diameter or radius;
c) solve practical problems involving area and perimeter; and
d) describe and determine the volume and surface area of a rectangular prism.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
of a circle to its diameter. • The ratio of the circumference to the diameter of a circle is a constant value, pi (π), which can be approximated by measuring various sizes of circles. • The fractional approximation of pi generally used is $\frac{22}{7}$. • The decimal approximation of pi generally used is 3.14. • The circumference of a circle is computed using $C = \pi d$ or $C = 2\pi r$, where d is the diameter and r is the radius of the circle. • The area of a circle is computed using the formula $A = \pi r^2$, where r is the radius of the circle. • The surface area of a rectangular prism is the sum of the areas of all six faces ($SA = 2lw + 2lh + 2wh$). • The volume of a rectangular prism is computed by multiplying the area of the base, B, (length x width) by the height of the prism ($V = lwh = Bh$ ~~or B=Bh~~). Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#measurement		• ~~Determine if a problem situation involving polygons of four or fewer sides represents the application of perimeter or area.~~ • ~~Determine the circumference and/or area of a circle, using various tools.~~

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- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students expand the informal experiences they have had with geometry in the elementary grades and develop a solid foundation for the exploration of geometry in high school. Spatial reasoning skills are essential to the formal inductive and deductive reasoning skills required in subsequent mathematics learning.
- Students learn geometric relationships by visualizing, comparing, constructing, sketching, measuring, transforming, and classifying geometric figures. A variety of tools such as geoboards, pattern blocks, dot paper, patty paper, miras, and geometry software provides experiences that help students discover geometric concepts. Students describe, classify, and compare plane and solid figures according to their attributes. They develop and extend understanding of geometric transformations in the coordinate plane.
- Students apply their understanding of perimeter and area from the elementary grades in order to build conceptual understanding of the surface area and volume of prisms, cylinders, pyramids, and cones. They use visualization, measurement, and proportional reasoning skills to develop an understanding of the effect of scale change on distance, area, and volume. They develop and reinforce proportional reasoning skills through the study of similar figures.
- Students explore and develop an understanding of the Pythagorean Theorem. Mastery of the use of the Pythagorean Theorem has far-reaching impact on subsequent mathematics learning and life experiences.

The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.)

- **Level 3: Abstraction.** Definitions are meaningful, with relationships being perceived between properties and between figures. Logical implications and class inclusions are understood, but the role and significance of deduction is not understood. (Students should transition to this level during grades 5 and 6 and fully attain it before taking ~~A~~algebra.)
- **Level 4: Deduction.** Students can construct proofs, understand the role of axioms and definitions, and know the meaning of necessary and sufficient conditions. Students should be able to supply reasons for steps in a proof. (Students should transition to this level before taking ~~G~~geometry.)

6.11 The student will

a) identify the coordinates of a point in a coordinate plane; and

b) graph ordered pairs in a coordinate plane.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• In a coordinate plane, the coordinates of a point are typically represented by the ordered pair (*x*, *y*), where *x* is the first coordinate and *y* is the second coordinate. However, any letters may be used to label the axes and the corresponding ordered pairs. • ~~The first coordinate of a point is its distance from the vertical number line along a horizontal line.~~ • ~~The second coordinate of a point is its distance from the horizontal number line along a vertical line.~~ • ~~In a plane, a point can be located by its distances from two intersecting perpendicular number lines. The distance from one line is measured along a line parallel to the other line.~~ • The quadrants of a coordinate plane are the four regions created by the two intersecting perpendicular number lines. Quadrants are named in counterclockwise order. The signs on the ordered pairs for quadrant I are (+,+); for quadrant II, (–,+); for quadrant III, (–, –); and for quadrant IV, (+,–). • In a coordinate plane, the origin is the point at the intersection of the x-axis and y-axis; the coordinates of this point are (0,0). • For all points on the x-axis, the y-coordinate is 0. For all points on the y-axis, the x-coordinate is 0. ~~When a point lies on the y-axis, the x-coordinate is always 0.~~ • The coordinates may be used to name the point. (e.g., the point (2,7)). It is not necessary to say "the point	~~**All students should**~~ • Can any given point be represented by more than one ordered pair? ~~Understand that t~~ The coordinates of a point define its unique location in a coordinate plane. Any given point is defined by only one ordered pair. • In naming a point in the plane, does the order of the two coordinates matter? Yes. The first coordinate tells the location of the point to the left or right of the y-axis and the second point tells the location of the point above or below the x-axis. Point (0, 0) is at the origin.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify and label the axes of a coordinate plane. • Identify and label the quadrants of a coordinate plane. • Identify the quadrant ~~or axis~~ ~~in which~~ or the axis on which a ~~an ordered pair~~ point is positioned by examining the ~~ordered pair~~ coordinates (ordered pair) of the point. • Graph ordered pairs in the four quadrants and on the axes of a coordinate plane. • Identify ordered pairs represented by points in the four quadrants and on the axes of the coordinate plane.

6.11 The student will

a) identify the coordinates of a point in a coordinate plane; and

b) graph ordered pairs in a coordinate plane.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
whose coordinates are (2,7)".		

6.12 The student will determine congruence of segments, angles, and polygons.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Congruent figures have exactly the same size and the same shape. • Noncongruent figures may have the same shape but not the same size. • The symbol for congruency is ≅ . • The ~~matching or~~ corresponding angles of congruent polygons have the same measure, and the ~~matching or~~ corresponding sides of congruent polygons have the same measure. • The ~~direct comparison~~ determination of ~~congruent or noncongruent~~ the congruence or noncongruence of two figures can be accomplished by placing one figure on top of the other or by comparing the measurements of ~~measuring~~ all sides and angles. • Construction of congruent line segments, angles, and polygons helps students understand congruency.	~~**All students should**~~ • ~~Understand the meaning of congruence.~~ • Given two congruent figures, what inferences can be drawn about how the figures are related? The congruent figures will have exactly the same size and shape. • Given two congruent polygons, what inferences can be drawn about how the polygons are related? Corresponding angles of congruent polygons will have the same measure. ~~and~~ ~~c~~Corresponding sides of congruent polygons will have the same ~~length~~ measure.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Characterize polygons as congruent and noncongruent according to the measures of their sides and angles. • Determine the congruence of segments, angles, and polygons ~~by direct comparison,~~ given their attributes.

6.13 The student will describe and identify properties of quadrilaterals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A quadrilateral is a closed planar (two-dimensional) figure with four sides that are line segments. • A parallelogram is a quadrilateral whose opposite sides are parallel and opposite angles are congruent. ~~• For all parallelograms, both pairs of opposite sides and both pairs of opposite angles are congruent.~~ ~~• Parallelograms have special characteristics (such as both pairs of opposite sides are parallel and congruent) that are true for any parallelogram.~~ • A rectangle is a parallelogram with four right angles. • Rectangles have special characteristics (such as diagonals are perpendicular bisectors) that are true for any rectangle. • To bisect means to divide into two equal parts. • A square is a rectangle with four congruent sides or a rhombus with four right angles. • A rhombus is a parallelogram with four congruent sides. ~~• A trapezoid is a quadrilateral with exactly one pair of parallel sides.~~ • A trapezoid is a quadrilateral with exactly one pair of parallel sides. The parallel sides are called *bases,* and the nonparallel sides are called *legs*. If the legs have the same length, then the trapezoid is an isosceles trapezoid. ~~• A trapezoid with congruent, nonparallel sides is called an isosceles trapezoid.~~	~~**All students should**~~ • Can a figure belong to more than one subset of quadrilaterals? Any figure that has the attributes of more than one subset of quadrilaterals can belong to more than one subset. For example, rectangles have opposite sides of equal length. Squares have all 4 sides of equal length thereby meeting the attributes of both subsets.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Sort and classify polygons as quadrilaterals, parallelograms, rectangles, trapezoids, kites, rhombi, and squares based on their properties. Properties include number of parallel sides, angle measures and number of congruent sides. • Identify the sum of the measures of the angles of a quadrilateral as 360°.

6.13 The student will describe and identify properties of quadrilaterals.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A kite is a quadrilateral with two pairs of adjacent congruent sides. One pair of opposite angles is congruent. • Quadrilaterals can be sorted according to common attributes, using a variety of materials. • Quadrilaterals can be classified by the number of parallel sides: a parallelogram, rectangle, rhombus, and square each have two pairs of parallel sides; a trapezoid has only one pair of parallel sides; other quadrilaterals have no parallel sides. • Quadrilaterals can be classified by the measures of their angles: a rectangle has four 90° angles; a trapezoid may have none, one, or two 90° angles. • Quadrilaterals can be classified by the number of congruent sides: a rhombus has four congruent sides; a square, which is a rhombus with four right angles, also has four congruent sides; a parallelogram and a rectangle each have two pairs of congruent sides. • A square is a special type of both a rectangle and a rhombus, which are special types of parallelograms, which are special types of quadrilaterals. • The sum of the measures of the angles of a quadrilateral is 360°. • A chart ~~or~~, graphic organizer or Venn Diagram can be made to organize quadrilaterals according to attributes such as sides and/or angles. Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#geometry		

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- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop an awareness of the power of data analysis and probability by building on their natural curiosity about data and making predictions.
- Students explore methods of data collection and use technology to represent data with various types of graphs. They learn that different types of graphs represent different types of data effectively. They use measures of ~~central tendency~~ center and dispersion to analyze and interpret data.
- Students integrate their understanding of rational numbers and proportional reasoning into the study of statistics and probability.
- Students explore experimental and theoretical probability through experiments and simulations by using concrete, active learning activities.

6.14 The student, given a problem situation, will
a) construct circle graphs;
b) draw conclusions and make predictions, using circle graphs; and
c) compare and contrast graphs that present information from the same data set.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• To collect data for any problem situation, an experiment can be designed, a survey can be conducted, or other data-gathering strategies can be used. The data can be organized, displayed, analyzed, and interpreted to answer the problem. • ~~Data can be discrete or continuous.~~ • Different types of graphs are used to display different types of data. – Bar graphs use categorical (discrete) data (e.g., months or eye color). – Line graphs use continuous data (e.g., temperature and time). – Circle graphs show a relationship of the parts to a whole. • All graphs include a title, and data categories should have labels. • A scale should be chosen that is appropriate for the data. • A key is essential to explain how to read the graph. • A title is essential to explain what the graph represents. • Data are analyzed by describing the various features and elements of a graph. Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#statistics	~~**All students should**~~ • ~~Understand that data can be displayed in a variety of graphical representations.~~ • ~~Select and use appropriate statistical methods to analyze data.~~ • ~~Understand that different types of representations can tell different things about the same data.~~ • What type of data are best presented in a circle graph? Circle graphs are best used for data showing a relationship of the parts to the whole.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Collect data sets of no more than 20 items by using tally sheets, surveys, observations, questionnaires, interviews, and polls.~~ • ~~Organize data by using lists, charts, and tables.~~ • ~~Organize and display data in bar and line graphs, displaying the information as clearly as possible by using increments of whole numbers, fractions, and decimals rounded to the nearest tenth.~~ • Collect, ~~O~~organize and display data in circle graphs by depicting information as fractional. ~~parts that are limited to halves, fourths, and eighths.~~ • Draw conclusions and make predictions about data presented in a circle graph. • Compare and contrast data presented in a circle graph with the same data represented in other graphical forms ~~studied in the previous grade level.~~ • ~~Decide which type of graph is appropriate for a given situation.~~ ~~– Bar graphs are used to display categorical (discrete) data.~~ ~~– Line graphs are used to display continuous data.~~

6.15 The student will

a) describe mean as balance point; and

b) decide which measure of center is appropriate for a given purpose.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Measures of ~~central tendency~~ center are types of averages for a data set. They represent numbers that ~~best~~ describe a data set. Mean, median, and mode are measures of ~~central tendency~~ center that are useful for describing the average for different situations. – Mean works well for sets of data with no very high or low numbers. – Median is a good choice when data sets have a couple of values much higher or lower than most of the others. – Mode is a good descriptor to use when the set of data has some identical values or when data are not conducive to computation of other measures of central tendency, as when working with data in a yes or no survey. • The mean is the numerical average of the data set and is found by adding the numbers in the data set together and dividing the sum by the number of data pieces in the set. • In grade 5 mathematics, mean is defined as fair-share. • Mean can be defined as the point on a number line where the data distribution is balanced. This means that the sum of the distances from the mean of all the points above the mean is equal to the sum of the distances of all the data points below the mean. This is the concept of mean as the balance point. • Defining mean as balance point is a prerequisite for understanding standard deviation.	~~**All students should**~~ • ~~Understand that measures of central tendency are types of averages for a data set.~~ • ~~Understand that mean, median, and mode are measures of central tendency that are useful for describing data in different situations.~~ • ~~Understand that the range describes the spread of a set of data.~~ • What does the phrase "measure of center" mean? This is a collective term for the 3 types of averages for a set of data – mean, median and mode. • What is meant by mean as balance point? Mean can be defined as the point on a number line where the data distribution is balanced. This means that the sum of the distances from the mean of all the points above the mean is equal to the sum of the distances of all the data points below the mean. This is the concept of mean as the balance point.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find the mean for a set of data. • Describe the three measures of ~~central tendency~~ center and a situation in which each would best represent a set of data. • Identify and draw a number line that demonstrates the concept of mean as balance point for a set of data.

6.15 The student will

a) describe mean as balance point; and

b) decide which measure of center is appropriate for a given purpose.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The median is the middle value of a data set in ranked order. If there are an odd number of pieces of data, the median is the middle value in ranked order. If there is an even number of pieces of data, the median is the numerical average of the two middle values. • The mode is the piece of data that occurs most frequently. If no value occurs more often than any other, there is no mode. If there is more than one value that occurs most often, all these most-frequently-occurring values are modes. When there are exactly two modes, the data set is bimodal. ~~- For 2, 3, 4, 5, 5, 6, 7, 8, 8, 8, 9, 11, the mode is 8.~~ ~~- For 2, 3, 4, 5, 5, 5, 7, 8, 8, 8, 9, 11, the modes are 5 and 8 (bimodal).~~ ~~- For 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 17, there is no mode.~~ • ~~The range is the difference between the greatest and least values in a set of data and shows the spread in a set of data.~~		

6.16 The student will

a) compare and contrast dependent and independent events; and

b) determine probabilities for dependent and independent events.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The probability of an event occurring is equal to the ratio of desired outcomes to the total number of possible outcomes (sample space). • The probability of an event occurring can be represented as a ratio or the equivalent fraction, decimal, or percent. • The probability of an event occurring is a ratio between 0 and 1. – A probability of 0 means the event will never occur. – A probability of 1 means the event will always occur. • A simple event is one event (e.g., pulling one sock out of a drawer and examining the probability of getting one color). • Events are independent when the outcome of one has no effect on the outcome of the other. For example, rolling a number cube and flipping a coin are independent events. • The probability of two independent events is found by using the following formula: $P(A\,and\,B) = P(A) \cdot P(B)$ Ex: When rolling two number cubes simultaneously, what is the probability of rolling a 3 on one cube and a 4 on the other? $P(3\,and\,4) = P(3) \cdot P(4) = \frac{1}{6} \cdot \frac{1}{6} = \frac{1}{36}$ • Events are dependent when the outcome of one	~~**All students should**~~ • ~~Understand that a probability can be expressed as a ratio, decimal, or percent~~. • How can you determine if a situation involves dependent or independent events? Events are independent when the outcome of one has no effect on the outcome of the other. Events are dependent when the outcome of one event is influenced by the outcome of the other.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine whether two events are dependent or independent. • Compare and contrast dependent and independent events. • Determine the probability of two dependent events. • Determine the probability of two independent events.

6.16 The student will

a) compare and contrast dependent and independent events; and

b) determine probabilities for dependent and independent events.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
event is influenced by the outcome of the other. For example, when drawing two marbles from a bag, *not* replacing the first after it is drawn affects the outcome of the second draw. • The probability of two dependent events is found by using the following formula: $P(A \text{ and } B) = P(A) \cdot P(B \text{ after } A)$ Ex: You have a bag holding a blue ball, a red ball, and a yellow ball. What is the probability of picking a blue ball out of the bag on the first pick and then *without* replacing the blue ball in the bag, picking a red ball on the second pick? $P(\text{blue } \textit{and} \text{ red}) = P(\text{blue}) \cdot P(\text{red } \textit{after} \text{ blue}) = \frac{1}{3} \cdot \frac{1}{2} = \frac{1}{6}$		

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

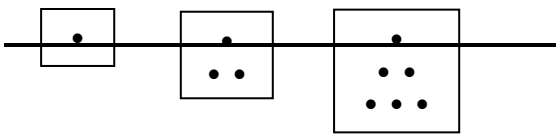
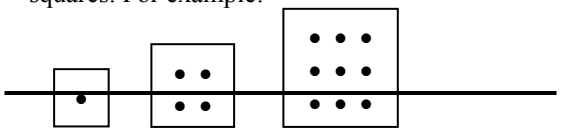
Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students extend their knowledge of patterns developed in the elementary grades and through life experiences by investigating and describing functional relationships.
- Students learn to use algebraic concepts and terms appropriately. These concepts and terms include *variable, term, coefficient, exponent, expression, equation, inequality, domain*, and *range*. Developing a beginning knowledge of algebra is a major focus of mathematics learning in the middle grades.
- Students learn to solve equations by using concrete materials. They expand their skills from one-step to two-step equations and inequalities.
- Students learn to represent relations by using ordered pairs, tables, rules, and graphs. Graphing in the coordinate plane linear equations in two variables is a focus of the study of functions.

6.17 The student will identify and extend geometric and arithmetic sequences.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Numerical patterns may include linear and exponential growth, perfect squares, triangular and other polygonal numbers, or Fibonacci numbers. • Arithmetic and geometric sequences are types of numerical patterns. • In the numerical pattern of an arithmetic sequence, students must determine the difference, called the *common difference*, between each succeeding number in order to determine what is added to each previous number to obtain the next number. Sample numerical patterns are 6, 9, 12, 15, 18, …; and 5, 7, 9, 11, 13, …. • In geometric number patterns, students must determine what each number is multiplied by to obtain the next number in the geometric sequence. This multiplier is called the *common ratio*. Sample geometric number patterns include 2, 4, 8, 16, 32, …; 1, 5, 25, 125, 625, …; and 80, 20, 5, 1.25, … • Strategies to recognize and describe the differences between terms in numerical patterns include, but are not limited to, examining the change between consecutive terms, ~~looking for prime numbers,~~ and finding common factors. An example is the pattern 1, 2, 4, 7, 11, 16,… • ~~Strategies to recognize and describe geometric patterns include, but are not limited to, examining flips, slides, turns, growth, and symmetry. Rotation (turn) is the result of turning a figure around a point or a vertex. Translation (slide) is the result of sliding a figure in any direction within a plane. Dilatation (scale increase or decrease) is the result of enlarging or shrinking a figure by a scale amount. Reflection~~	~~**All students should**~~ • ~~Understand that mathematical patterns can be represented in various forms, geometrically or numerically.~~ • ~~Understand that patterns regularly occur in everyday life.~~ • ~~Understand that patterns can be recognized, extended, or generalized~~. • ~~Understand that numerical patterns may involve adding or multiplying by the same number.~~ • ~~Understand that geometric patterns may involve shape, size, angles, transformations of shapes, and growth.~~ • What is the difference between an arithmetic and a geometric sequence? While both are numerical patterns, arithmetic sequences are additive and geometric sequences are multiplicative.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Investigate and apply strategies to recognize and describe the change between terms in ~~numerical~~ arithmetic patterns. • Investigate and apply strategies to recognize and describe geometric patterns. • Describe verbally and in writing the relationships between consecutive terms in an ~~numerical~~ arithmetic or geometric ~~pattern~~ sequence. • Extend and apply ~~numerical~~ arithmetic and geometric ~~patterns~~ sequences to similar situations. • ~~Create~~ ~~Using a table as an organizing tool, e~~Extend ~~numerical~~ arithmetic and geometric ~~patterns~~ sequences in a table by using a given rule or mathematical relationship. • ~~Describe numerical and geometric patterns, including triangular numbers.~~ • Compare and contrast arithmetic and geometric sequences. • Identify the common difference for a given arithmetic sequence. • Identify the common ratio for a given geometric sequence.

6.17 The student will identify and extend geometric and arithmetic sequences.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~(flip) is the result of flipping a figure over a line.~~ • ~~The first five triangular numbers are 1, 3, 6, 10, and 15. A triangular number can be represented geometrically as a certain number of dots arranged in a triangle, with one dot in the first (top) row and each succeeding lower row having one more dot that the row above it. To find the next triangular number, a new row is added to an existing triangle, and total number of dots counted. Students should make the connection between the number of new dots in the triangle and the corresponding triangular number. Triangular numbers can be represented as a growing pattern of triangles.~~  • ~~A square number can be represented geometrically as the number of dots in a square array. Square numbers are perfect squares and are the numbers that result from multiplying any whole number by itself (e.g., 36 = 6 × 6). Square numbers (1, 4, 9, 16, …) can be represented as a growing pattern of squares. For example:~~  • ~~The possible number of patterns is infinite.~~ • ~~The simplest types of patterns are repeating patterns. In such patterns, students need to identify the basic unit of the pattern and repeat it.~~ • ~~Growing patterns are more difficult for students to~~		

6.17 The student will identify and extend geometric and arithmetic sequences.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~understand than repeating patterns because not only must they determine what comes next, they must also begin the process of generalization. Students need experiences with growing patterns both in numerical and geometric formats.~~		

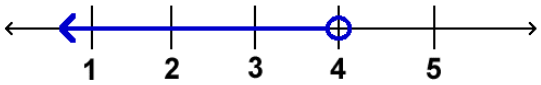
6.18 The student will solve one-step linear equations in one variable involving whole number coefficients and positive rational solutions.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A one-step linear equation is an equation that requires one operation to solve. • A mathematical expression contains a variable or a combination of variables, numbers, and/or operation symbols and represents a mathematical relationship. An expression cannot be solved. • A term is a number, variable, product, or quotient in an expression of sums and/or differences. In $7x^2 + 5x - 3$, there are three terms, $7x^2$, $5x$, and 3. • A coefficient is the numerical factor in a term. For example, in the term $3xy^2$, 3 is the coefficient; in the term z, 1 is the coefficient. • Positive rational solutions are limited to whole numbers and positive fractions and decimals. • An equation is a mathematical sentence stating that two expressions are equal. • A variable is a symbol (placeholder) used to represent an unspecified member of a set.	~~**All students should**~~ • ~~Understand that physical objects can be used to represent and solve algebraic equations.~~ • ~~Understand that in an equation, the equal sign indicates that the value on the left side of the sign is the same as the value on the right side.~~ • When solving an equation, why is it necessary to perform the same operation on both sides of an equal sign? ~~Understand that to~~ To maintain equality, an operation performed on one side of an equation must be performed on the other side.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections and representation to** • Represent and solve a one-step equation, using a variety of concrete materials such as colored chips ~~on an equation mat~~, ~~algebra tiles~~, algeblocks or weights on a balance scale. • Solve a one-step equation by demonstrating the steps algebraically. • Identify and ~~U~~use the following algebraic terms appropriately: *equation*, v*ariable, expression, term,* and *coefficient*. • ~~Identify examples of equations, variables, terms, and coefficients.~~

6.19 The student will investigate and recognize
a) the identity properties for addition and multiplication;
b) the multiplicative property of zero; and
c) the inverse property for multiplication.

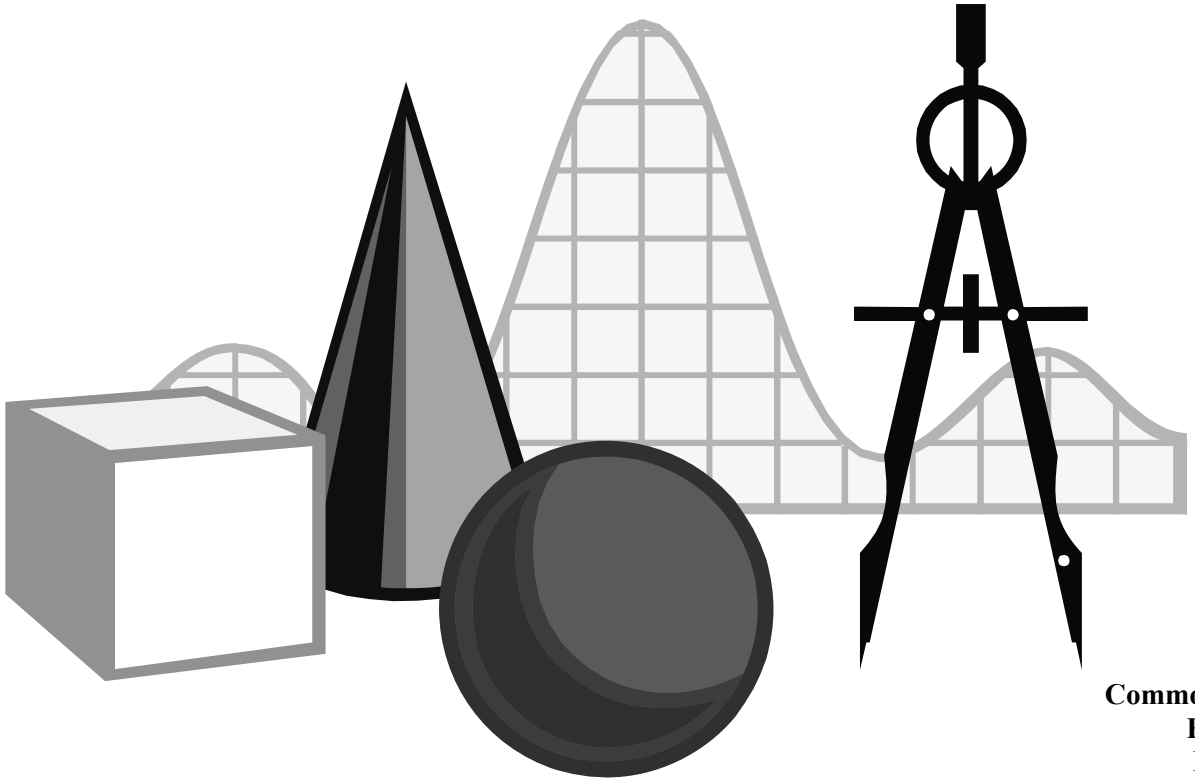
UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Identity elements are numbers that combine with other numbers without changing the other numbers. The additive identity is zero (0). The multiplicative identity is one (1). There are no identity elements for subtraction and division. • The additive identity property states that the sum of any real number and zero is equal to the given real number (e.g., $5 + 0 = 5$). • The multiplicative identity property states that the product of any real number and one is equal to the given real number (e.g., $8 \cdot 1 = 8$). • Inverses are numbers that combine with other numbers and result in identity elements. • The multiplicative inverse property states that the product of a number and its multiplicative inverse (or reciprocal) always equals one (e.g., $4 \cdot \frac{1}{4} = 1$). • Zero has no multiplicative inverse. • The multiplicative property of zero states that the product of any real number and zero is zero. • Division by zero is not a possible arithmetic operation. Division by zero is undefined. Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#nns	~~**All students should**~~ • ~~Understand that using the properties of operations with real numbers helps with understanding mathematical relationships.~~ • ~~Understand how to use these properties when computing.~~ • How are the identity properties for multiplication and addition the same? Different? For each operation the identity elements are numbers that combine with other numbers without changing the value of the other numbers. The additive identity is zero (0). The multiplicative identity is one (1). • What is the result of multiplying any real number by zero? The product is always zero. • Do all real numbers have a multiplicative inverse? No. Zero has no multiplicative inverse because there is no real number that can be multiplied by zero resulting in a product of one.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the real number equation that represents each property of operations with real numbers, when given several real number equations. • ~~Explore the properties of real numbers, using diagrams and manipulatives~~. • Test the validity of properties by using examples of the properties of operations on real numbers. • Identify the property of operations with real numbers that is illustrated by a real number equation. NOTE: The commutative, associative and distributive properties are taught in previous grades.

6.20 The student will graph inequalities on a number line.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Inequalities using the < or > symbols are represented on a number line with an open circle on the number and a shaded line over the solution set. Ex: x < 4  • When graphing x ≤ 4 fill in the circle above the 4 to indicate that the 4 is included. • Inequalities using the ≤ *or* ≥ symbols are represented on a number line with a closed circle on the number and shaded line in the direction of the solution set. • The solution set to an inequality is the set of all numbers that make the inequality true. • It is important for students to see inequalities written with the variable before the inequality symbol and after. For example x > -6 and 7 > y.	~~**All students should**~~ • ~~Does the order of the elements~~ ~~i~~In an inequality, does the order of the elements matter? Yes, the order does matter. For example, x > 5 is not the same relationship as 5 > x. However, x > 5 is the same relationship as 5 < x.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections and representation to** • Given a simple inequality with integers, graph the relationship on a number line. • Given the graph of a simple inequality with integers, represent the inequality two different ways using the symbols <, >, ≤ *and* ≥ .

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Grade 7



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Board of Education
Richmond, Virginia
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The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students in the middle grades focus on mastering rational numbers. Rational numbers play a critical role in the development of proportional reasoning and advanced mathematical thinking. The study of rational numbers builds on the understanding of whole numbers, fractions, and decimals developed by students in the elementary grades. Proportional reasoning is the key to making connections to most middle school mathematics topics.
- Students develop an understanding of integers and rational numbers by using concrete, pictorial, and abstract representations. They learn how to use equivalent representations of fractions, decimals, and percents and recognize the advantages and disadvantages of each type of representation. Flexible thinking about rational number representations is encouraged when students solve problems.
- Students develop an understanding of the properties of operations on real numbers through experiences with rational numbers and by applying the order of operations.
- Students use a variety of concrete, pictorial, and abstract representations to develop proportional reasoning skills. Ratios and proportions are a major focus of mathematics learning in the middle grades.

7.1 The student will

a) investigate and describe the concept of negative exponents for powers of ten;
b) determine scientific notation for numbers greater than zero;
c) compare and order fractions, decimals, percents and numbers written in scientific notation;
d) determine square roots; and
e) identify and describe absolute value for rational numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Negative exponents for powers of 10 are used to represent numbers between 0 and 1. (e.g., $10^{-3} = \frac{1}{10^3} = 0.001$). • Negative exponents for powers of 10 can be investigated through patterns such as: $10^2 = 100$ $10^1 = 10$ $10^0 = 1$ $10^{-1} = \frac{1}{10^1} = \frac{1}{10} = 0.1$ • ~~Fractions, decimals, and percents are three different representations of the same number. Some numbers also can be represented in scientific notation.~~ • A number followed by a percent symbol (%) is equivalent to that number with a denominator of 100 (e.g., $\frac{3}{5} = \frac{60}{100} = 0.60 = 60\%$). • Scientific notation is used to represent very large or very small numbers. • A number written in scientific notation is the product of two factors — a decimal greater than or equal to 1 but less than 10, and a power of 10	~~**All students should**~~ • ~~Understand that a number can be represented as a decimal, fraction, percent, and/or in scientific notation.~~ • ~~Develop strategies to compare, order, and determine equivalency among fractions, decimals, and percents.~~ • ~~Understand real-life uses of scientific notation.~~ • When should scientific notation be used? Scientific notation should be used whenever the situation calls for use of very large or very small numbers. • How are fractions, decimals and percents related? Any rational number can be represented in fraction, decimal and percent form. • What does a negative exponent mean when the base is 10? A base of 10 raised to a negative exponent represents a number between 0 and 1. • How is taking a square root different from squaring a number? Squaring a number and taking a square root are inverse operations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize powers of 10 with negative exponents by examining patterns. • Write a power of 10 with a negative exponent in fraction and decimal form. • Write a number greater than ~~10~~ 0 in scientific notation. • Recognize a number greater than 0 in scientific notation. • Compare~~, order,~~ and determine equivalent relationships between numbers larger than ~~10~~ 0 written in scientific notation. • Represent a number in fraction, decimal, and percent forms. ~~Fractions will have denominators of 12 or less.~~ • Compare, order, and determine equivalent relationships among fractions, decimals, and percents. Decimals are limited to the thousandths place, and percents are limited to the tenths place. Ordering is limited to no more than 4 numbers. • Order no more than 3 numbers greater than 0 written in scientific notation.

7.1 The student will

a) investigate and describe the concept of negative exponents for powers of ten;
b) determine scientific notation for numbers greater than zero;
c) compare and order fractions, decimals, percents and numbers written in scientific notation;
d) determine square roots; and
e) identify and describe absolute value for rational numbers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
(e.g., $3.1 \times 10^5 = 310{,}000$ and $2.85 \times 10^{-4} = 0.000285$). ~~• Decimals, fractions, and percents can be compared using concrete materials (e.g., base ten blocks, decimal squares, and grid paper).~~ • Equivalent relationships among fractions, decimals, and percents can be determined by using manipulatives (e.g., fraction bars, ~~base ten~~ Base-10 blocks, fraction circles, graph paper, number lines and calculators). • A square root of a number is a number which, when multiplied by itself, produces the given number (e.g., $\sqrt{121}$ is 11 since 11 x 11 = 121). • The square of a number can be represented geometrically as the length of a side of the square. • The absolute value of a number is the distance from 0 on the number line regardless of direction. (e.g., $\left\|\frac{-1}{2}\right\| = \frac{1}{2}$).	~~**All students should**~~ • Why is the absolute value of a number positive? The absolute value of a number represents distance from zero on a number line regardless of direction. Distance is positive.	~~• Compare very large numbers, using scientific notation.~~ ~~**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to**~~ ~~• Order no more than five numbers written as fractions, decimals, percents, and numbers larger than 10 written in scientific notation in ascending (least to greatest) or descending (greatest to least) order.~~ • Determine the square root of a perfect square less than or equal to 400. • Demonstrate absolute value using a number line. • Determine the absolute value of a rational number.

7.2 The student will describe and represent arithmetic and geometric sequences using variable expressions.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• In the numeric pattern of an arithmetic sequence, students must determine the difference, called the *common difference*, between each succeeding number in order to determine what is added to each previous number to obtain the next number. • In geometric sequences, students must determine what each number is multiplied by in order to obtain the next number in the geometric sequence. This multiplier is called the *common ratio*. Sample geometric sequences include – 2, 4, 8, 16, 32, …; 1, 5, 25, 125, 625, …; and – 80, 20, 5, 1.25, …. • A variable expression can be written to express the relationship between two consecutive terms of a sequence (e.g.: 3, 6, 9, 12…). If n represents a number in this sequence, the next term in the sequence can be determined using the variable expression: n + 3 (e.g.: 1, 5, 25, 125…). If n represents a number in the sequence, the next term in the sequence can be determined by using the variable expression 5n.)	~~**All students should**~~ • When are variable expressions used? Variable expressions can express the relationship between two consecutive terms in a sequence.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Analyze situations to discover a variety of patterns~~. • Analyze numeric and geometric sequences to discover a variety of patterns. • Identify the common difference in an arithmetic sequence. • Identify the common ratio in a geometric sequence. • Given an arithmetic or geometric sequence, write a variable expression to describe the relationship between two consecutive terms in the sequence.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop conceptual and algorithmic understanding of operations with integers and rational numbers through concrete activities and discussions that bring meaning to why procedures work and make sense.
- Students develop and refine estimation strategies and develop an understanding of when to use algorithms and when to use calculators. Students learn when exact answers are appropriate and when, as in many life experiences, estimates are equally appropriate.
- Students learn to make sense of the mathematical tools they use by making valid judgments of the reasonableness of answers.
- Students reinforce skills with operations with whole numbers, fractions, and decimals through problem solving and application activities.

7.3 The student will

a) model addition, subtraction, multiplication and division of integers; and

b) add, subtract, multiply, and divide integers.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The set of integers is the set of whole numbers and their opposites (e.g., … –3, –2, –1, 0, 1, 2, 3, …). • Integers are used in ~~real-life~~ practical situations, such as temperature changes (above/below zero), balance in a checking account (deposits/withdrawals), and changes in altitude (above/below sea level). • Concrete experiences in formulating rules for adding and subtracting integers should be explored by examining patterns using calculators, along a number line and using manipulatives, such as two-color counters, or by using algeblocks. • Concrete experiences in formulating rules for multiplying and dividing integers should be explored by examining patterns with calculators, along a number line and using manipulatives, such as two-color counters, or by using algeblocks. Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/# under computation. For additional information on using Algeblocks, go to http://www.vdoe.whro.org/A_Blocks05/index.html	~~**All students should**~~ • ~~Develop and apply strategies involving mathematical operations with integers.~~ • ~~Understand how problems in daily life can be represented and solved by using integers.~~ • The sums, differences, products and quotients of integers are either positive, zero, or negative. How can this be demonstrated? This can be demonstrated through the use of patterns and models.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Model addition, subtraction, multiplication and division of integers using pictorial representations of concrete manipulatives. • Add, subtract, multiply and divide integers . • ~~Formulate rules for adding integers.~~ • ~~Formulate rules for subtracting integers.~~ • ~~Formulate rules for multiplying integers.~~ • ~~Formulate rules for dividing integers.~~ • Simplify numerical expressions involving addition, subtraction, multiplication and~~/or~~ division of integers using order of operations. • Solve practical problems involving addition, subtraction, multiplication, and division with integers.

7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A proportion is a statement of equality between two ratios. • ~~A common property relates the numerators of the two ratios, and another common property relates the denominators of the two ratios. For example, both numerators relate to one property, such as length, while both denominators relate to another property, such as width. Alternatively, both numerators could relate to scale lengths, while both denominators relate to actual lengths.~~ • ~~The dimensions of a scale model are proportional to the corresponding dimensions of the object (e.g., a blueprint of a house floor plan is proportional to the actual dimensions of the floor).~~ • A proportion can be written as $\frac{a}{b} = \frac{c}{d}$, $a:b = c:d$, or a is to b as c is to d. • A proportion can be solved by finding the product of the means and the product of the extremes. For example, in the proportion $a:b = c:d$, a and d are the extremes and b and c are the means. If values are substituted for a, b, c, and d such as 5:12 = 10:24, then the product of extremes (5×24) is equal to the product of the means (12×10). • In a proportional situation, both quantities increase or decrease together. • In a proportional situation, two quantities increase multiplicatively. Both are multiplied by the same factor. • A proportion can be solved by finding equivalent fractions.	~~**All students should**~~ • ~~Understand that a proportion is an equation showing that two ratios are equal.~~ • ~~Understand how to set up a proportion, given the relationship between two items.~~ • What makes two quantities proportional? ~~Understand that when t~~ Two quantities are proportional, when a change in one quantity corresponds to a predictable change in the other. • ~~Understand that proportions are useful in solving many types of problems.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Write proportions that represent equivalent relationships between two sets. • Solve a proportion to find a missing term. • ~~Apply proportions to solve problems that involve percents.~~ • ~~Apply proportions to solve practical problems. Calculators may be used.~~ • Apply proportions to convert units of measurement between the U.S. Customary System and the metric system. Calculators may be used. • Apply proportions to solve practical problems, including scale drawings. Scale factors shall have denominators no greater than 12 and ~~/or~~ decimals no less than tenths. Calculators may be used. • Using 10% as a benchmark, mentally compute 5%, 10%, 15%, or 20% in a practical situation such as tips, tax and discounts. • Solve problems involving tips, tax, and discounts. Limit problems to only one percent computation per problem.

7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~There is a distinction between a proportion and the idea of equivalent fractions. Equivalent fractions are symbols for the same quantity or amount and they represent the same rational number in different forms.~~ • ~~A rate is a special ratio that always has a denominator of 1~~. A rate is a ratio that compares two quantities measured in different units. A unit rate is a rate with a denominator of 1. Examples of rates include miles/hour and revolutions/minute. ~~A rate compares measures of different types.~~ • Proportions are used in everyday contexts, such as speed, recipe conversions, scale drawings, map reading, reducing and enlarging, comparison shopping, and monetary conversions. • Proportions can be used to convert between measurement systems. For example: if 2 inches is about 5 cm, how many inches are in 16 cm? – $\frac{2inches}{x} = \frac{5cm}{16cm}$ • A percent is a special ratio in which the denominator is 100. • Proportions can be used to represent percent problems as follows: – $\frac{percent}{100} = \frac{part}{whole}$		

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop the measurement skills that provide a natural context and connection among many mathematics concepts. Estimation skills are developed in determining length, weight/mass, liquid volume/capacity, and angle measure. Measurement is an essential part of mathematical explorations throughout the school year.
- Students continue to focus on experiences in which they measure objects physically and develop a deep understanding of the concepts and processes of measurement. Physical experiences in measuring various objects and quantities promote the long-term retention and understanding of measurement. Actual measurement activities are used to determine length, weight/mass, and liquid volume/capacity.
- Students examine perimeter, area, and volume, using concrete materials and practical situations. Students focus their study of surface area and volume on rectangular prisms, cylinders, pyramids, and cones.

7.5 The student will

a) describe volume and surface area of cylinders;
b) solve practical problems involving the volume and surface area of rectangular prisms and cylinders; and
c) describe how changing one measured attribute of a rectangular prism affects its volume and surface area.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The area of a rectangle is computed by multiplying the lengths of two adjacent sides. • The area of a circle is computed by squaring the radius and multiplying that product by π ($A = \pi r^2$, where $\pi \approx 3.14$ or $\frac{22}{7}$). • A rectangular prism can be represented on a flat surface as a net that contains six rectangles — two that have measures of the length and width of the base, two others that have measures of the length and height, and two others that have measures of the width and height. The surface area of a rectangular prism is the sum of the areas of all six faces ($SA = 2lw + 2lh + 2wh$). • A cylinder can be represented on a flat surface as a net that contains two circles (bases for the cylinder) and one rectangular region whose length is the circumference of the circular base and whose width is the height of the cylinder. The surface area of the cylinder is the area of the two circles and the rectangle ($SA = 2\pi r^2 + 2\pi rh$). • The volume of a rectangular prism is computed by multiplying the area of the base, B, (length times width) by the height of the prism ($V = lwh = Bh$). • The volume of a cylinder is computed by multiplying the area of the base, B, (πr^2) by the height of the cylinder ($V = \pi r^2 h = Bh$). • There is a direct relationship between changing one	~~**All students should**~~ • ~~Understand how to apply volume and surface area in real-life situations.~~ • ~~Understand the derivation of formulas related to volume and surface area of polygons.~~ • How are volume and surface area related? Volume is a measure of the amount a container holds while surface area is the sum of the areas of the surfaces on the container. • How does the volume of a rectangular prism change when one of the attributes is increased? There is a direct relationship between the volume of a rectangular prism increasing when the length of one of the attributes of the prism is changed by a scale factor.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine if a practical problem involving a rectangular prism or cylinder represents the application of volume or surface area. • ~~Develop a procedure and formula for finding~~ Find the surface area of a rectangular prism. • Solve practical problems that require finding the surface area of a rectangular prism. • ~~Develop a procedure and formula for finding~~ Find the surface area of a cylinder. • Solve practical problems that require finding the surface area of a cylinder. • ~~Develop a procedure and formula for finding~~ Find the volume of a rectangular prism. • Solve practical problems that require finding the volume of a rectangular prism. • Find the volume of a cylinder. • Solve practical problems that require finding the volume of a cylinder. • Describe how the volume of a rectangular prism is affected when one measured attribute is multiplied by a scale factor. Problems will be limited to changing attributes by scale factors only. • Describe how the surface area of a rectangular prism

7.5 The student will

a) describe volume and surface area of cylinders;
b) solve practical problems involving the volume and surface area of rectangular prisms and cylinders; and
c) describe how changing one measured attribute of a rectangular prism affects its volume and surface area.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
measured attribute of a rectangular prism by a scale factor and its volume. For example, doubling the length of a prism will double its volume. This direct relationship does not hold true for surface area. Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#geometry		is affected when one measured attribute is multiplied by a scale factor. Problems will be limited to changing attributes by scale factors only.

7.6 The student will determine whether plane figures – quadrilaterals and triangles – are similar and write proportions to express the relationships between corresponding sides of similar figures.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Two polygons are similar if corresponding (matching) angles are congruent and the lengths of corresponding sides are proportional. • Congruent polygons have the same size and shape. • Congruent polygons are similar polygons for which the ratio of the corresponding sides is 1:1. • Similarity statements can be used to determine corresponding parts of similar figures such as: $\Delta ABC \sim \Delta DEF$ $\angle$A corresponds to $\angle$D $\overline{AB}$ corresponds to $\overline{DE}$ • The traditional notation for marking ~~corresponding~~ congruent angles is to use a curve on each angle. Denote which angles ~~correspond~~ are congruent with the same number of curved lines. For example, if $\angle$A ~~corresponding~~ congruent to $\angle$B , then both angles will be marked with the same number of curved lines. • ~~Corresponding~~ Congruent sides are denoted with the same number of hatch ~~lines~~marks on each ~~corresponding~~ congruent side. For example, a side on a polygon with 2 hatch marks ~~corresponds~~ is congruent to the side with 2 hatch marks on a similar polygon. Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#geometry	~~All students should~~ • ~~Understand that similar geometric figures have the same shape but may have different sizes~~. • ~~Understand how ratios and proportions can be used to determine the length of something that cannot be measured directly~~ • How do polygons that are similar compare to polygons that are congruent? Congruent polygons have the same size and shape. Similar polygons have the same shape, and corresponding angles between the similar figures are congruent. However, the lengths of the corresponding sides are proportional. All congruent polygons are considered similar with the ratio of the corresponding sides being 1:1.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify corresponding sides and corresponding and congruent angles of similar figures using the traditional notation of curved lines for the angles and hatch marks on the sides. • Write proportions to express the relationships between the lengths of corresponding sides of similar figures. • ~~Examine congruence of corresponding angles and proportionality of corresponding sides to d~~ Determine if quadrilaterals or triangles are similar~~.~~ by examining congruence of corresponding angles and proportionality of corresponding sides. • Given two similar figures, write similarity statements using symbols such as $\Delta ABC \sim \Delta DEF$, $\angle$A corresponds to $\angle$D, and $\overline{AB}$ corresponds to $\overline{DE}$.

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Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students expand the informal experiences they have had with geometry in the elementary grades and develop a solid foundation for the exploration of geometry in high school. Spatial reasoning skills are essential to the formal inductive and deductive reasoning skills required in subsequent mathematics learning.
- Students learn geometric relationships by visualizing, comparing, constructing, sketching, measuring, transforming, and classifying geometric figures. A variety of tools such as geoboards, pattern blocks, dot paper, patty paper, miras, and geometry software provides experiences that help students discover geometric concepts. Students describe, classify, and compare plane and solid figures according to their attributes. They develop and extend understanding of geometric transformations in the coordinate plane.
- Students apply their understanding of perimeter and area from the elementary grades in order to build conceptual understanding of the surface area and volume of prisms, cylinders, pyramids, and cones. They use visualization, measurement, and proportional reasoning skills to develop an understanding of the effect of scale change on distance, area, and volume. They develop and reinforce proportional reasoning skills through the study of similar figures.
- Students explore and develop an understanding of the Pythagorean Theorem. Mastery of the use of the Pythagorean Theorem has far-reaching impact on subsequent mathematics learning and life experiences.

The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.)

- **Level 3: Abstraction.** Definitions are meaningful, with relationships being perceived between properties and between figures. Logical implications and class inclusions are understood, but the role and significance of deduction is not understood. (Students should transition to this level during grades 5 and 6 and fully attain it before taking ~~A~~algebra.)
- **Level 4: Deduction.** Students can construct proofs, understand the role of axioms and definitions, and know the meaning of necessary and sufficient conditions. Students should be able to supply reasons for steps in a proof. (Students should transition to this level before taking ~~G~~geometry.)

7.7 The student will compare and contrast the following quadrilaterals based on properties: parallelogram, rectangle, square, rhombus, and trapezoid.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A quadrilateral is a closed plane (two-dimensional) figure with four sides that are line segments. • A parallelogram is a quadrilateral whose opposite sides are parallel and opposite angles are congruent. ~~Opposite angles of a parallelogram are congruent.~~ • A rectangle is a parallelogram with four right angles. The diagonals of a rectangle are the same length and bisect each other. • A square is a rectangle with four congruent sides whose diagonals are perpendicular. ~~or~~ A square is a rhombus with four right angles. • A rhombus is a parallelogram with four congruent sides whose diagonals bisect each other and intersect at right angles. • A trapezoid is a quadrilateral with exactly one pair of parallel sides. • A trapezoid with congruent, nonparallel sides is called an *isosceles trapezoid*. • Quadrilaterals can be sorted according to common attributes, using a variety of materials. • A chart, ~~or~~ graphic organizer, or Venn diagram can be made to organize quadrilaterals according to attributes such as sides and/or angles. • ~~For all parallelograms, both pairs of opposite sides and both pairs of opposite angles are congruent~~. • ~~Parallelograms have special characteristics (such as both pairs of opposite sides are parallel and congruent) that are true for any parallelogram.~~ • ~~Rectangles~~ Squares ~~have special characteristics~~	~~**All students should**~~ • ~~Understand that quadrilaterals can be classified according to the attributes of their sides and/or angles.~~ • ~~Understand that a quadrilateral can belong to one or more subsets of the set of quadrilaterals.~~ • Why can some quadrilaterals be classified in more than one category? ~~Understand that e~~ Every quadrilateral in a subset has all of the defining attributes of the subset. For example, if a quadrilateral is a rhombus, it has all the attributes of a rhombus. However, if that rhombus also has the additional property of 4 right angles, then that rhombus is also a square.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and contrast attributes of the following quadrilaterals: parallelogram, rectangle, square, rhombus, and trapezoid. • Identify the classification(s) to which a quadrilateral belongs, using deductive reasoning and inference. • ~~Classify quadrilaterals, using deductive reasoning and inference.~~

7.7 The student will compare and contrast the following quadrilaterals based on properties: parallelogram, rectangle, square, rhombus, and trapezoid.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~(such as diagonals are perpendicular bisectors) that are true for any rectangle square.~~ Additional resources on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#geometry		

7.8 The student, given a polygon in the coordinate plane, will represent transformations (reflections, dilations, rotations, and translations) by graphing in the coordinate plane.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A rotation of a geometric figure is a turn of the figure around a fixed point. The point may or may not be on the figure. The fixed point is called the *center of rotation*. • A translation of a geometric figure is a slide of the figure in which all the points on the figure move the same distance in the same direction. • A reflection is a transformation that reflects a figure across a line in the plane. • A dilation of a geometric figure is a transformation that changes the ~~shape~~ size of a figure by ~~changing the distance of all the points in the figure from a specific line. The distance is changed by~~ a ~~multiplicative~~ scale factor to create a similar figure. • The image of a polygon is the resulting polygon after the transformation. The preimage is the polygon before the transformation. • A transformation of preimage point A can be denoted as the image A' (read as "A prime").	~~**All students should**~~ • ~~Understand that the size or shape of a figure does not change by a translation or rotation.~~ • How does the transformation of a figure affect the size, shape and position of that figure? Translations, rotations and reflections do not change the size or shape of a figure. A dilation of a figure and the original figure are similar. ~~Understand that~~ Reflections, translations and rotations usually change the position of the figure.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the coordinates of the image of a ~~polygon~~ right triangle or rectangle that has been translated either vertically, ~~or~~ horizontally, or a combination of a vertical and horizontal translation. • Identify the coordinates of the image of a right triangle or rectangle that has been rotated 90° or 180° about the origin. • Identify the coordinates of the image of a right triangle or a rectangle that has been reflected over the x- or y-axis. • Identify the coordinates of a right triangle or rectangle that has been dilated. The center of the dilation will be the origin. • Sketch the image of a ~~polygon~~ right triangle or rectangle translated vertically or horizontally. • Sketch the image of a right triangle or rectangle that has been rotated 90° or 180° about the origin. • Sketch the image of a right triangle or rectangle that has been reflected over the x- or y-axis. • Sketch the image of a dilation of a right triangle or rectangle limited to a scale factor of $\frac{1}{4}$, $\frac{1}{2}$, 2, 3 or 4.

In the middle grades, the focus of mathematics learning is to

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- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop an awareness of the power of data analysis and probability by building on their natural curiosity about data and making predictions.
- Students explore methods of data collection and use technology to represent data with various types of graphs. They learn that different types of graphs represent different types of data effectively. They use measures of ~~central tendency~~ center and dispersion to analyze and interpret data.
- Students integrate their understanding of rational numbers and proportional reasoning into the study of statistics and probability.
- Students explore experimental and theoretical probability through experiments and simulations by using concrete, active learning activities.

7.9 The student will investigate and describe the difference between the experimental probability and theoretical probability of an event.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Theoretical probability of an event is the expected probability and can be found with a formula. • Theoretical probability of an event = $\frac{\text{number of possible favorable outcomes}}{\text{total number of possible outcomes}}$. • The experimental probability of an event is determined by carrying out a simulation or an experiment. • The experimental probability = $\frac{\text{number of times desired outcomes occur}}{\text{number of trials in the experiment}}$. • In experimental probability, as the number of trials increases, the experimental probability gets closer to the theoretical probability (Law of Large Numbers).	~~**All students should**~~ • ~~Understand the meaning of theoretical probability.~~ • ~~Understand the difference between theoretical and experimental probability.~~ • What is the difference between the theoretical and experimental probability of an event? Theoretical probability of an event is the expected probability and can be found with a formula. ~~Understand that~~ The experimental probability of an event is determined by carrying out a simulation or an experiment. ~~Understand that i~~ In experimental probability, as the number of trials increases, the experimental probability gets closer to the theoretical probability.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine the theoretical probability of an event. • Determine the experimental probability of an event. • Describe changes in the experimental probability as the number of trials increases. • Investigate and describe the difference between the probability of an event found through experiment or simulation versus the theoretical probability of that same event.

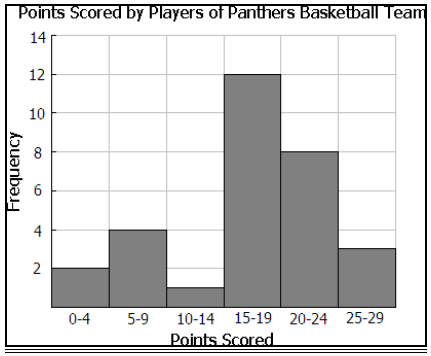
7.10 The student will determine the probability of compound events, using the Fundamental (Basic) Counting Principle.

UNDERSTANDING THE STANDARD (Teacher Notes)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The Fundamental (Basic) Counting Principle is a computational procedure to determine the number of possible ~~arrangements~~ outcomes of several ~~objects~~ events. It is the product of the number of ~~ways~~ outcomes for each ~~object~~ event that can be chosen individually (e.g., the possible ~~arrangements~~ outcomes or outfits of four shirts, two pants, and three shoes is 4 · 2 · 3 or 24). • Tree diagrams are used to illustrate possible outcomes of events. They can be used to support the Fundamental (Basic) Counting Principle. • A compound event combines two or more simple events. For example, a bag contains 4 red, 3 green and 2 blue marbles. What is the probability of selecting a green and then a blue marble?	~~**All students should**~~ • What is the Fundamental (Basic) Counting Principle? ~~Understand that t~~ The Fundamental (Basic) Counting Principle is a computational procedure used to determine the number of possible ~~arrangements (combinations or~~ outcomes~~)~~ of several ~~objects~~ events. • What is the role of the Fundamental (Basic) Counting Principle in determining the probability of compound events? The Fundamental (Basic) Counting Principle is used to determine the number of outcomes of each event. It is the product of the number of outcomes for each event that can be chosen individually.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compute the number of possible ~~arrangements~~ outcomes ~~of no more than three types of objects~~ by using the Fundamental (Basic) Counting Principle. • Determine the probability of a compound event containing no more than 2 events.

7.11 The student, given data in a practical situation, will
a) construct and analyze histograms; and
b) compare and contrast histograms with other types of graphs presenting information from the same data set.

UNDERSTANDING THE STANDARD
(Background Information for Instructor Use Only)

- All graphs tell a story and include a title and labels that describe the data.
- A histogram is a form of bar graph in which the categories are consecutive and equal intervals. The length or height of each bar is determined by the number of data elements frequency falling into a particular interval.



- A frequency distribution shows how often an item, a number, or range of numbers occurs. It can be used to construct a histogram.

STUDENTS WHO READ GARFIELD

Age Group	Tally	Frequency	Cumulative Frequency	
7-10	𝍸 II	7	7	
11-14	𝍸 II	7	14	← 7 + 7
15-18	III	3	17	← 14 + 3
19-22	III	3	20	← 17 + 3

- ~~Inferences, conjectures, and predictions are based on~~

ESSENTIAL UNDERSTANDINGS

~~**All students should**~~

- ~~Understand that graphs tell a story.~~
- ~~Understand that data can be displayed in a variety of graphical representations.~~
- ~~Select and use appropriate statistical methods to analyze data.~~
- ~~Understand that different types of graphs can be used to represent the same data in a variety of ways~~
- What type of data are most appropriate to display in a histogram?
  Numerical data that can be characterized using consecutive intervals are best displayed in a histogram.

ESSENTIAL KNOWLEDGE AND SKILLS

The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to

- Collect, analyze, display, and interpret a data set ~~of no more than 20 items,~~ using histograms. For collection and display of raw data, limit the data to 20 items.
- ~~Organize data not exceeding 20 items into tables and/or graphs that provide a clear representation of dispersion or convergence of the data.~~
- Determine patterns and relationships within data sets (e.g., trends).
- Make inferences, conjectures, and predictions based on analysis of a set of data. ~~Raw data displayed should not exceed 20 items.~~
- Compare and contrast histograms with line plots, circle graphs, and stem and leaf plots presenting information from the same data set.

7.11 The student, given data in a practical situation, will
a) construct and analyze histograms; and
b) compare and contrast histograms with other types of graphs presenting information from the same data set.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~careful data analysis.~~ • Comparisons, predictions and inferences are made by examining characteristics of a data set displayed in a variety of graphical representations to draw conclusions. • The information displayed in different graphs may be examined to determine how data are or are not related, ascertaining differences between characteristics (comparisons), trends that suggest what new data might be like (predictions), and/or "what could happen if" (inference). • ~~Methods of collecting and analyzing data are factors in determining the validity of any inferences or arguments based on the data.~~		

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct through active learning experiences a more advanced understanding of mathematics;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students extend their knowledge of patterns developed in the elementary grades and through ~~life~~ practical experiences by investigating and describing functional relationships.
- Students learn to use algebraic concepts and terms appropriately. These concepts and terms include *variable, term, coefficient, exponent, expression, equation, inequality, domain*, and *range*. Developing a beginning knowledge of algebra is a major focus of mathematics learning in the middle grades.
- Students learn to solve equations by using concrete materials. They expand their skills from one-step to two-step equations and inequalities.
- Students learn to represent relations by using ordered pairs, tables, rules, and graphs. Graphing in the coordinate plane linear equations in two variables is a focus of the study of functions.

7.12 The student will represent relationships with tables, graphs, rules, and words.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~A function is a rule that pairs exactly one element of a set with one and only one element of another set. An example of a function is that which relates the sum, *s*, of the measures of the interior angles of a polygon to the number, *n*, of sides:~~ ~~$s = (n - 2) \cdot 180$.~~ • Rules that relate elements in two sets can be represented by word sentences, equations, tables of values, graphs, or illustrated pictorially. • A relation is any set of ordered pairs. For each first member, there may be many second members. • A function is a relation in which there is one and only one second member for each first member. • As a table of values, a function has a unique value assigned to the second variable for each value of the first variable. • As a graph, a function is any curve (including straight lines) such that any vertical line would pass through the curve only once. • Some relations are functions; all functions are relations.	~~**All students should**~~ • ~~Understand that patterns in mathematics are often represented by using a rule that relates elements in one set to elements in another set.~~ • What are the different ways to represent the relationship between two sets of numbers? ~~Understand that r~~ Rules that relate elements in two sets can be represented by word sentences, equations, tables of values, graphs or illustrated pictorially.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Represent a variety of patterns, using tables, graphs, rules, and words, in order to investigate and describe functional relationships.~~ • ~~Generalize a variety of patterns.~~ • Given a function in words, represent the function as an equation. • Given an equation that represents a relation, write a table of values. • Given a table of values, write an equation that represents a relation. • Graph in a coordinate plane ordered pairs that are represented on a table.

7.13 The student will

a) write verbal expressions as algebraic expressions and sentences as equations and vice versa; and

b) evaluate algebraic expressions for given replacement values of the variables.

UNDERSTANDING THE STANDARD (Teacher Notes)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• An expression is a name for a number. • An expression that contains a variable is a variable expression. • An expression that contains only numbers is a numerical expression. • A verbal expression is a word phrase (e.g., "the sum of two consecutive integers"). • A verbal sentence is a complete word statement (e.g., "The sum of two consecutive integers is five."). • An algebraic expression is a variable expression that contains at least one variable (e.g., $2x - 5$). • An algebraic equation is a mathematical statement that says that two expressions are equal (e.g., $2x + 1 = 5$). • ~~Key words in translating verbal expressions/ sentences to algebraic expressions/equations may include words and their translations such as: *is* to =, *of* to *multiplication*, *more than* to +, *less than* to −, *increased by* to +, and *decreased by* to −.~~ • To evaluate an algebraic expression, substitute a given replacement value for a variable and apply the order of operations. For example, if a = 3 and b = -2 then 5a + b can be evaluated as: 5(3) + (-2) = 15 + (-2) = 13.	~~**All students should**~~ • How can algebraic expressions and equations be written? ~~Understand that w~~ Word phrases and sentences can be used to represent~~ed as~~ algebraic expressions and equations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Write verbal expressions as algebraic expressions. Expressions will be limited to no more than 2 operations. • Write verbal sentences as algebraic equations. Equations will contain no more than 1 variable term. • Translate algebraic expressions and equations to verbal expressions and sentences. Expressions will be limited to no more than 2 operations. • Identify examples of expressions and equations. • Apply the order of operations to evaluate expressions for given replacement values of the variables. Limit the number of replacements to no more than 3 per expression.

7.13 The student will

a) write verbal expressions as algebraic expressions and sentences as equations and vice versa; and

b) evaluate algebraic expressions for given replacement values of the variables.

UNDERSTANDING THE STANDARD (Teacher Notes)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
Additional information on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#nns		

7.14 The student will

a) solve one- and two-step linear equations in one variable; and

b) solve practical problems requiring the solution of one- and two-step linear equations.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• An equation is a mathematical sentence that states that two expressions are equal. • A one-step equation is defined as an equation that requires the use of one operation to solve (e.g., $x + 3 = -4$). • ~~A one-step inequality is defined as an inequality that requires the use one operation to solve (e.g., $x - 4 > 9$).~~ • The inverse operation for addition is subtraction, and the inverse operation for multiplication is division. • A two-step equation is defined as an equation that requires the use of two operations to solve. E.g., $2x + 1 = -5$ $-5 = 2x + 1$ $\frac{x-7}{3} = 4$	~~**All students should**~~ • ~~Understand that different words have specific and different meanings to describe algebraic relationships.~~ • When solving an equation, why is it important to perform identical operations on each side of the equal sign? An operation that is performed on one side of an equation must be performed on the other side to maintain equality.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Apply the following algebraic terms appropriately: *equation, inequality*, and *expression*.~~ • ~~Identify examples of equations, inequalities, and expressions.~~ • Represent and demonstrate steps ~~in~~for solving one- and two-step equations in one variable using concrete materials, pictorial representations and algebraic sentences. • Solve practical problems that require the solution of a one- or two-step linear equation.

7.15 The student will

a) solve one-step inequalities in one variable; and

b) graph solutions to inequalities on the number line.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A one-step inequality is defined as an inequality that requires the use of one operation to solve (e.g., $x - 4 > 9$). • The inverse operation for addition is subtraction, and the inverse operation for multiplication is division. • When both expressions of an inequality are multiplied or divided by a negative number, the inequality symbol reverses (e.g., $-3x < 15$ is equivalent to $x > -5$). • Solutions to inequalities can be represented using a number line.	~~**All students should**~~ • ~~Understand that an operation that is performed on one side of an equation must be performed on the other side to maintain equality.~~ • ~~Understand procedures for solving inequalities.~~ • ~~Understand that when both expressions are multiplied or divided by a negative number, the inequality symbol reverses~~. • How are the procedures for solving equations and inequalities the same? The procedures are the same except for the case when an inequality is multiplied or divided on both sides by a negative number. Then the inequality sign is changed from less than to greater than, or greater than to less than. • How is the solution to an inequality different from that of a linear equation? In an inequality, there can be more than one value for the variable that makes the inequality true.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Represent and demonstrate steps in solving equations in one variable, using concrete materials, pictorial representations, and algebraic sentences.~~ • Represent and demonstrate steps in solving inequalities in one variable, using concrete materials, pictorial representations, and algebraic sentences. • ~~Translate one-step word problems and practical problems into algebraic equations and solve them.~~ • Graph solutions to inequalities on the number line. • Identify a numerical value that satisfies the inequality.

7.16 The student will apply the following properties of operations with real numbers:
a) the commutative and associative properties for addition and multiplication;
b) the distributive property;
c) the additive and multiplicative identity properties;
d) the additive and multiplicative inverse properties; and
e) the multiplicative property of zero.

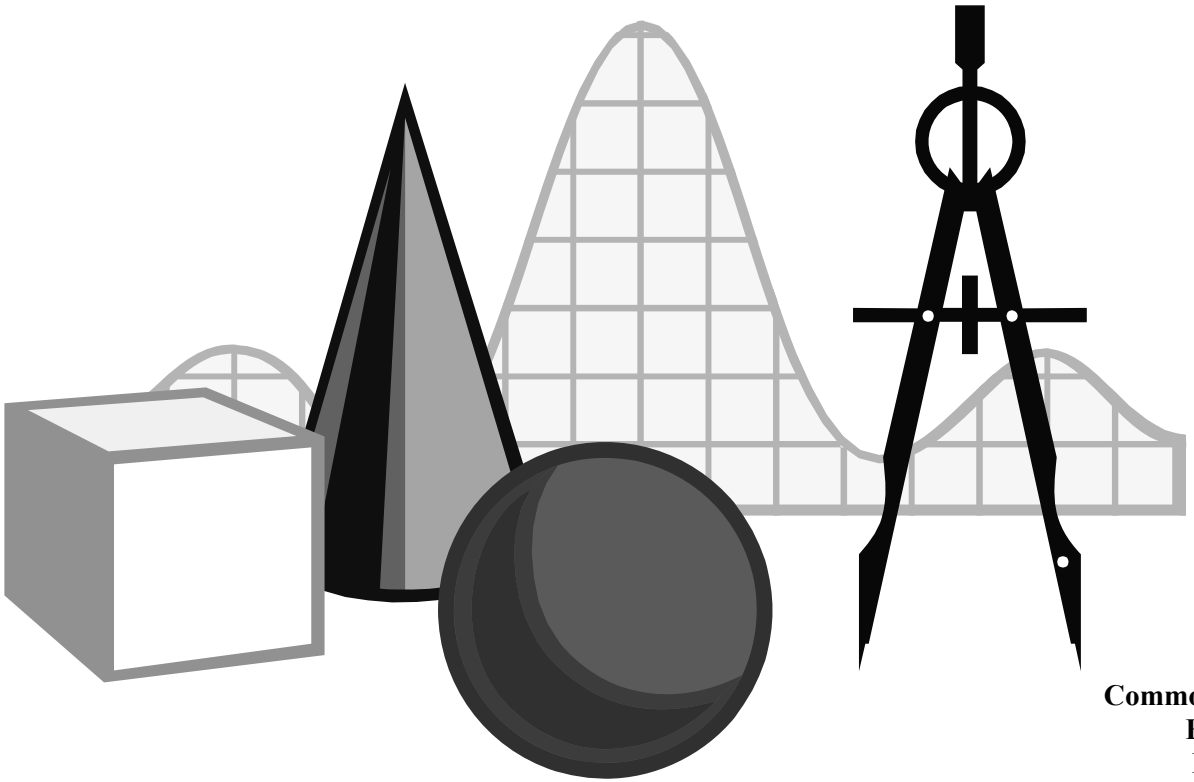
UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The commutative property for addition states that changing the order of the addends does not change the sum (e.g., 5 + 4 = 4 + 5). • The commutative property for multiplication states that changing the order of the factors does not change the product (e.g., 5 · 4 = 4 · 5). • The associative property of addition states that regrouping the addends does not change the sum [e.g., 5 + (4 + 3) = (5 + 4) + 3]. • The associative property of multiplication states that regrouping the factors does not change the product [e.g., 5 · (4 · 3) = (5 · 4) · 3]. • Subtraction and division are neither commutative nor associative. • The distributive property states that the product of a number and the sum (or difference) of two other numbers equals the sum (or difference) of the products of the number and each other number [e.g., 5 · (3 + 7) = (5 · 3) + (5 · 7), or 5 · (3 – 7) = (5 · 3) – (5 · 7)]. • Identity elements are numbers that combine with other numbers without changing the other numbers. The additive identity is zero (0). The multiplicative identity is one (1). There are no identity elements for subtraction and division. • The additive identity property states that the sum of	~~**All students should**~~ • Why is it important to apply properties of operations when simplifying expressions? ~~Understand that u~~ Using the properties of operations with real numbers helps with understanding mathematical relationships. • ~~Understand how to use these properties when computing.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify the real number equation that represents each property of operations with real numbers, when given several real number equations.~~ • ~~Explore the properties of real numbers, using diagrams and manipulatives.~~ • ~~Test the validity of properties by using examples of the properties of operations on real numbers.~~ • ~~Identify the property of operations with real numbers that is illustrated by a real number equation~~. • Identify properties of operations used in simplifying expressions. • Apply the properties of operations to simplify expressions.

7.16 The student will apply the following properties of operations with real numbers:
a) the commutative and associative properties for addition and multiplication;
b) the distributive property;
c) the additive and multiplicative identity properties;
d) the additive and multiplicative inverse properties; and
e) the multiplicative property of zero.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
any real number and zero is equal to the given real number (e.g., 5 + 0 = 5). • The multiplicative identity property states that the product of any real number and one is equal to the given real number (e.g., 8 · 1 = 8). • Inverses are numbers that combine with other numbers and result in identity elements [e.g., 5 + (–5) = 0; $\frac{1}{5} \cdot 5 = 1$]. • The additive inverse property states that the sum of a number and its additive inverse always equals zero [e.g., 5 + (–5) = 0]. • The multiplicative inverse property states that the product of a number and its multiplicative inverse (or reciprocal) always equals one (e.g., $4 \cdot \frac{1}{4} = 1$). • Zero has no multiplicative inverse. • The multiplicative property of zero states that the product of any real number and zero is zero. • Division by zero is not a possible arithmetic operation. Division by zero is undefined. Additional information on this topic can be found at http://www.doe.virginia.gov/VDOE/middle-math-strategies/#nns		

MATHEMATICS STANDARDS OF LEARNING
PROPOSED CURRICULUM FRAMEWORK

Grade 8



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Board of Education
Richmond, Virginia
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The Virginia Department of Education does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities.

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Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into three columns: Understanding the Standard; Essential Understandings; and Essential Knowledge and Skills. The purpose of each column is explained below.

Understanding the Standard
This section includes background information for the teacher (K-8). It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan lessons focusing on the standard.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students in the middle grades focus on mastering rational numbers. Rational numbers play a critical role in the development of proportional reasoning and advanced mathematical thinking. The study of rational numbers builds on the understanding of whole numbers, fractions, and decimals developed by students in the elementary grades. Proportional reasoning is the key to making connections to most middle school mathematics topics.
- Students develop an understanding of integers and rational numbers by using concrete, pictorial, and abstract representations. They learn how to use equivalent representations of fractions, decimals, and percents and recognize the advantages and disadvantages of each type of representation. Flexible thinking about rational-number representations is encouraged when students solve problems.
- Students develop an understanding of the properties of operations on real numbers through experiences with rational numbers and by applying the order of operations.
- Students use a variety of concrete, pictorial, and abstract representations to develop proportional reasoning skills. Ratios and proportions are a major focus of mathematics learning in the middle grades.

8.1 The student will

a) simplify numerical expressions involving positive exponents, using rational numbers, order of operations, and properties of operations with real numbers; and

b) compare and order decimals, fractions, percents, and numbers written in scientific notation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• *Expression* is a word used to designate any symbolic mathematical phrase that may contain numbers and/or variables. Expressions do not contain ~~an~~ equal or inequality signs. • The set of rational numbers ~~is~~ includes the set of all numbers that can be expressed as fractions in the form $\frac{a}{b}$ where *a* and *b* are integers and *b* does not equal zero ($\sqrt{25}$, $\frac{1}{4}$ -2.3, 75%, ~~4.59~~ $4.\overline{59}$). • A rational number is any number that can be written in fraction form. • A numerical expression contains only numbers and the operations on those numbers. • Expressions are simplified using the order of operations and the properties for operations with real numbers, i.e., associative, commutative, and distributive and inverse properties. • The order of operations, a mathematical convention, is as follows: Complete all operations within grouping symbols*. If there are grouping symbols within other grouping symbols (embedded), do the innermost operation first. Evaluate all exponential expressions. Multiply and/or divide in order from left to right. Add and/or subtract in order from left to right. *~~Grouping symbols include~~ ~~p~~Parentheses ( ), brackets [ ], braces { }, the absolute value $\lvert\ \rvert$, division/fraction bar −,	~~All students should~~ • ~~Understand that any real number can be shown represented on a number line~~. • What is the role of the order of operations when simplifying numerical expressions? The order of operations ~~describes~~ prescribes the order to use to ~~compute with rational numbers~~simplify a numerical expression. • How does the different ways rational numbers can be represented help us compare and order rational numbers? ~~Understand that n~~Numbers can be represented ~~—~~as decimals, fractions, percents, and in scientific notation. It is often useful to convert numbers to be compared and/or ordered to one representation (e.g., fractions, decimals or percents). • What is a rational number? A rational number is any number that can be written in fraction form. • When are numbers written in scientific notation? Scientific notation is used to represent very large and very small numbers.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Simplify numerical expressions containing: 1) exponents (where the base is a rational number and the exponent is a positive whole number); 2) fractions, decimals, integers and~~/or~~ square roots of perfect squares; and~~/or~~ 3) grouping symbols (no more than 2 embedded grouping symbols). Order of operations and properties of operations with real numbers should be used. • Compare and order no more than five fractions, decimals, percents, and numbers written in scientific notation using positive and~~/or~~ negative exponents. Ordering may be in ascending or descending order.

8.1 The student will

a) simplify numerical expressions involving positive exponents, using rational numbers, order of operations, and properties of operations with real numbers; and

b) compare and order decimals, fractions, percents, and numbers written in scientific notation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
and the square root symbol $\sqrt{\ }$ should be treated as grouping symbols. • A power of a number represents repeated multiplication of the number. For example, $(-5)^4$ means $(-5) \cdot (-5) \cdot (-5) \cdot (-5)$. The base is the number that is multiplied, and the exponent represents the number of times the base is used as a factor. In this example, (–5) is the base, and 4 is the exponent. The product is 625. Notice that the base appears inside the grouping symbols. The meaning changes with the removal of the grouping symbols. For example, -5^4 means $5 \cdot 5 \cdot 5 \cdot 5$ negated which results in a product of -625. The expression $-(5)^4$ means to take the opposite of $5 \cdot 5 \cdot 5 \cdot 5$ which is -625. Students should be exposed to all three representations. • Scientific notation is used to represent very large or very small numbers. • A number written in scientific notation is the product of two factors: a decimal greater than or equal to one but less than 10 multiplied by a power of 10 (e.g., $3.1 \times 10^5 = 310{,}000$ and $3.1 \times 10^{-5} = 0.000031$). • Any real number raised to the zero power is 1. The only exception to this rule is zero itself. Zero raised to the zero power is undefined. • All state approved scientific calculators use algebraic logic (follow the order of operations).		

8.2 The student will describe orally and in writing the relationships between the subsets of the real number system.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The set~~s~~ of real numbers includes natural numbers, ~~or~~ counting numbers, whole numbers, integers, rational and irrational numbers~~ are the subsets of the real number system~~. • The set of natural numbers is the set of counting numbers ~~(~~{1, 2, 3, 4, ...}~~)~~. • The set of whole numbers includes the set of all the natural numbers or counting numbers and zero ~~(~~{0, 1, 2, 3…}~~)~~. • The set of integers includes the set of whole numbers and their opposites ~~(~~{…-2, -1, 0, 1, 2…}~~)~~. • The set of rational numbers includes the set of all numbers that can be expressed as fractions in the form $\frac{a}{b}$ where a and b are integers and b does not equal zero ($\sqrt{25}$, $\frac{1}{4}$, -2.3, 75%, ~~4.59~~ $4.\overline{59}$) . • The set of irrational numbers is the set of all non-repeating, nonterminating decimals. An irrational number cannot be written in fraction form ~~(~~{ π , $\sqrt{2}$, 2, 1.232332333…}~~)~~.~~.~~ • ~~The set of real numbers is includes the sets of all rational and irrational numbers. An irrational number cannot be expressed as an integer or the quotient of integers.~~	~~**All students should**~~ • ~~Understand the relationship between the subsets of the real number system.~~ • How are the real numbers related? Some numbers can appear in more than one subset, e.g., 4 is an integer, a whole number, a counting or natural number and a rational number. The attributes of one subset can be contained in whole or in part in another subset.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe orally and in writing the relationships among the sets of natural or counting numbers, whole numbers, integers, rational numbers, irrational numbers, and real numbers. • Illustrate the relationships among the subsets of the real number system by using graphic organizers such as Venn diagrams. Subsets include ~~real numbers,~~ rational numbers, irrational numbers, integers, whole numbers, and natural or counting numbers. • Identify the subsets of the real number system to which a given number belongs. • Determine whether a given number is a member of a particular subset of the real number system, and explain why. • Describe each subset of the set of real numbers and include examples and nonexamples.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct through active learning experiences a more advanced understanding of mathematics;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop conceptual and algorithmic understanding of operations with integers and rational numbers through concrete activities and discussions that bring meaning to why procedures work and make sense.
- Students develop and refine estimation strategies and develop an understanding of when to use algorithms and when to use calculators. Students learn when exact answers are appropriate and when, as in many life experiences, estimates are equally appropriate.
- Students learn to make sense of the mathematical tools they use by making valid judgments of the reasonableness of answers.
- Students reinforce skills with operations with whole numbers, fractions, and decimals through problem solving and application activities.

8.3 The student will

a) solve practical problems involving rational numbers, percents, ratios, and proportions; and

b) determine the percent increase or decrease for a given situation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Practical problems may include, but not be limited to, those related to economics, sports, science, social sciences, transportation, and health. Some examples include problems involving the amount of a pay check per month, the discount price on a product, temperature, simple interest, sales tax and installment buying. • A percent is a special ratio with a denominator of 100. • A discount is a percent of the original price. The discount price is the original price minus the discount. • Simple interest for a number of years is determined by multiplying the principle by the rate of interest by the number of years of the loan or investment (I=prt). • The total value of an investment is equal to the sum of the original investment and the interest earned. • The total cost of a loan is equal to the sum of the original cost and the interest paid. • Percent increase and percent decrease are both percents of change. • Percent of change is the percent that a quantity increases or decreases.	~~**All students should**~~ • ~~Select an appropriate method or methods for computing with rational numbers and percents according to the context of the problem.~~ • ~~Understand how to set up a proportion given the relationship between two items.~~ • What is the difference between percent increase and percent decrease? Percent increase and percent decrease are both percents of change measuring the percent a quantity increases or decreases. Percent increase shows a growing change in the quantity while percent decrease shows a lessening change. • What is a percent? A percent is a special ratio with a denominator of 100.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Write a proportion given the relationship of equality between two ratios. • Solve practical problems by using computation procedures for whole numbers, integers, ~~rational numbers~~ fractions, percents, ratios, and proportions. Some problems may require the application of a formula. • Maintain a checkbook and check registry for five or fewer transactions. • Compute a discount or markup and the resulting sale price for one discount or markup. • Compute the percent increase or decrease for a one-step equation found in a real life situation. • Compute the sales tax or tip and resulting total. • Substitute values for variables in given formulas. For example, use the simple interest formula I=prt to determine the value of any missing variable when given specific information. • Compute the simple interest and~~/or~~ new balance earned in an investment or on a loan for a given number of years.

8.3 The student will

a) solve practical problems involving rational numbers, percents, ratios, and proportions; and

b) determine the percent increase or decrease for a given situation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Percent increase determines the rate of growth and may be calculated using the following ratio: Change (new – original) original. • For percent increase, ~~T~~the change will result in a positive number. • Percent decrease determines the rate of decline and may be calculated using the same ratio as percent increase. However, the change will result in a negative number.		

8.4 The student will apply the order of operations to evaluate algebraic expressions for given replacement values of the variables.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Algebraic expressions use operations with algebraic symbols (variables) and numbers. • Algebraic expressions are evaluated by ~~replacing the variables with numbers~~ substituting numbers for variables and applying the order of operations to simplify the resulting expression. • ~~The replacement values are the numbers that replace the variables in an algebraic expression.~~ • The order of operations is as follows: Complete all operations within grouping symbols*. If there are grouping symbols within other grouping symbols (embedded), do the innermost operation first. Evaluate all exponential expressions. Multiply and/or divide in order from left to right. Add and/or subtract in order from left to right. *~~Grouping symbols include~~ P~~p~~arentheses ( ), brackets [ ], braces { }, the absolute value $\lvert\ \rvert$, division/fraction bar −, and the square root symbol $\sqrt{\ }$ should be treated as grouping symbols.	~~**All students should**~~ • ~~Evaluate an algebraic expression by substituting a number for each variable and then simplifying the result.~~ • ~~Understand how to apply the order of operations after substituting given values for variables in algebraic expressions.~~ • What is the role of the order of operations when evaluating expressions? Using the order of operations assures only one correct answer for an expression.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Substitute numbers for variables in ~~an~~ algebraic expressions and simplify the expressions by using the order of operations. Exponents are positive and limited to ~~used are~~ whole numbers less than 4. Square roots are limited to perfect squares. • Apply the order of operations to evaluate formulas. Problems will be limited to positive exponents. Square roots may be included in the expressions but limited to perfect squares.

8.5 The student will

a) determine whether a given number is a perfect square; and

b) find the two consecutive whole numbers between which a square root lies.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A perfect square is a whole number whose square root is ~~a whole number~~ an integer (e.g., The square root of 25 is 5 and -5; thus, 25 is a perfect square). • The square root of a number is ~~that~~ any number which when multiplied by itself equals the number. • Whole numbers have both positive and negative roots. • Any whole number other than a perfect square has a square root that lies between two consecutive whole numbers. • The square root of a whole number that is not a perfect square is an irrational number (e.g., $\sqrt{2}$ is an irrational number). An irrational number cannot be expressed exactly as a ratio. • Students can use grid paper and estimation to determine what is needed to build a perfect square.	~~All students should~~ • ~~Understand that a perfect square is the product of a number multiplied by itself.~~ • ~~Develop strategies for finding the square root of a number.~~ • How does the area of a square relate to the square of a number? The area determines the perfect square number. If it is not a perfect square, the area provides a means for estimation. • Why do numbers have both positive and negative roots? The square root of a number is ~~that~~ any number which when multiplied by itself equals the number. A product, when multiplying two positive factors, is always the same as the product when multiplying their opposites. For example, if the number is 49, then $7 \cdot 7 = 49$ and $-7 \cdot -7 = 49$.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the perfect squares from 0 to ~~100~~ 400. • Identify the two consecutive whole numbers between which the square root of a given whole number from 0 to ~~100~~ 400 lies (e.g., $\sqrt{57}$ lies between 7 and 8 since $7^2 = 49$ and $8^2 = 64$). • Define a perfect square. • Find the positive or positive and negative square roots of a given whole number from 0 to 400. (Use the symbol $\sqrt{\ }$ to ask for the positive root and $-\sqrt{\ }$ when asking for the ~~positive and~~ negative root~~s~~.)

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop the measurement skills that provide a natural context and connection among many mathematics concepts. Estimation skills are developed in determining length, weight/mass, liquid volume/capacity, and angle measure. Measurement is an essential part of mathematical explorations throughout the school year.
- Students continue to focus on experiences in which they measure objects physically and develop a deep understanding of the concepts and processes of measurement. Physical experiences in measuring various objects and quantities promote the long-term retention and understanding of measurement. Actual measurement activities are used to determine length, weight/mass, and liquid volume/capacity.
- Students examine perimeter, area, and volume, using concrete materials and practical situations. Students focus their study of surface area and volume on rectangular prisms, cylinders, pyramids, and cones.

8.6 The student will

a) verify by measuring and describe the relationships among vertical angles, adjacent angles, supplementary angles, and complementary angles; and

b) measure angles of less than 360°.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Vertical angles are ~~the opposite angles~~ (all nonadjacent angles) formed by two intersecting lines. ~~and have only a vertex in common~~. Vertical angles are congruent and share a common vertex. • Complementary angles are any two angles such that the sum of their measures is 90°. • Supplementary angles are any two angles such that the sum of their measures is 180°. • Reflex angles measure more than 180°. • ~~Vertical angles are the opposite angles formed by two intersecting lines. Vertical angles are congruent and share a common vertex.~~ • Adjacent angles are any two angles that share a common side and a common vertex.	~~**All students should**~~ • ~~Understand the meaning of the term *angle*.~~ • ~~Understand how to use angle-measuring tools.~~ • ~~Understand that pairs of angles are named by their defining attributes.~~ • How are vertical, adjacent, complementary and supplementary angles related? Adjacent angles are any two angles that share a common side and a common vertex. Vertical angles will always be nonadjacent angles. Supplementary and complementary angles may or may not be adjacent.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Measure angles of less than 360° to the nearest degree, using appropriate tools. • Identify and describe the relationships among the ~~2~~ two types of angles formed by two intersecting lines. • Identify and describe pairs of vertical angles that are vertical. • Identify and describe pairs of angles that are supplementary. • Identify and describe pairs of angles that are complementary. • Identify and describe pairs of angles that are adjacent.

8.7 The student will

a) investigate and solve practical problems involving volume and surface area of prisms, cylinders, cones, and pyramids; and

b) describe how changing one measured attribute of the figure affects the volume and surface area.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A polyhedron is a solid figure whose faces are all polygons. • A pyramid is a polyhedron with a base that is a polygon and other faces that are triangles with a common vertex. • ~~The lateral area of a pyramid is the sum of the areas of the triangular faces.~~ • The area of the base of a pyramid is the area of the polygon which is the base. • The total surface area of a pyramid is the sum of the ~~lateral area~~ areas of the triangular faces and the area of the base. • The volume of a pyramid is $\frac{1}{3}Bh$, where B is the area of the base and h is the height. • ~~A circular cone is a geometric solid whose base is a circle and whose side is a surface composed of line segments connecting points on the base to a fixed point (the vertex) not on the base.~~ • ~~The lateral area of a right circular cone is the area of the surface connecting the base with the vertex and is equal to πrl, where l is the slant height.~~ • The area of the base of a circular cone is πr^2. • The surface area of a right circular cone is $\pi r^2 + \pi rl$. l represents the slant height of the cone.	~~**All students should**~~ • ~~Understand the derivation of formulas for volume and surface area of prisms, cylinders, cones, and pyramids.~~ • ~~Understand the differences between volume and surface area.~~ • How does the volume of a three-dimensional figure differ from its surface area? Volume is the amount a container holds. Surface area of a figure is the sum of the area on surfaces of the figure. • How are the formulas for the volume of prisms and cylinders similar? For both formulas you are finding the area of the base and multiplying that by the height. • How are the formulas for the volume of cones and pyramids similar? For cones you are finding 1/3 of the volume of the cylinder with the same size base and height. For pyramids you are finding 1/3 of the volume of the prism with the same size base and height. • In general what effect does changing one attribute of a prism by a scale factor have on the volume of the prism? When you increase or decrease the length, width or height of a prism by a factor greater than 1, the volume of the prism is also increased by that factor.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Distinguish between situations that are applications of surface area and those that are applications of volume. • Investigate and ~~C~~ compute the surface area of a square or triangular pyramid by finding the sum of the areas of the triangular faces and the base using concrete objects, nets, diagrams and formulas. • Investigate and ~~C~~ compute the surface area of a cone by calculating the sum of the areas of the side and the base, using concrete objects, nets, diagrams and formulas. • Investigate and compute the surface area of a right cylinder using concrete objects, nets, diagrams and formulas. • Investigate and compute the surface area of a rectangular prism using concrete objects, nets, diagrams and formulas. • Investigate and ~~C~~compute the volume ~~and surface area~~ of ~~rectangular solids (~~prisms~~)~~, cylinders, cones, and ~~square~~ pyramids, using concrete objects, nets, diagrams and formulas. • ~~Investigate and s~~ Solve practical problems involving volume and surface area of ~~rectangular solids (~~prisms~~)~~, cylinders, cones and pyramids. • Compare and contrast the volume of a prism with

8.7 The student will

a) investigate and solve practical problems involving volume and surface area of prisms, cylinders, cones, and pyramids; and

b) describe how changing one measured attribute of the figure affects the volume and surface area.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The volume of a cone is $\frac{1}{3}\pi r^2 h$, where h is the height and πr^2 is the area of the base. • The surface area of a right circular cylinder is $2\pi r^2 + 2\pi rh$. • The volume of a cylinder is the area of the base of the cylinder multiplied by the height. • The surface area of a rectangular prism is the sum of the areas of the ~~6~~six faces. • The volume of a rectangular prism is calculated by multiplying the length, width and height of the prism. • A prism is a solid figure that has a congruent pair of parallel bases and faces that are parallelograms. The surface area of a prism is the sum of the areas of the faces and bases. • When one attribute of a prism is changed through multiplication or division the volume increases by the same factor that the attribute increased by. For example, if a prism has a volume of 2 x 3 x 4, the volume is 24. However, if one of the attributes are doubled, the volume doubles. • The volume of a prism is Bh, where B is the area of the base and h is the height of the prism. • Nets are two-dimensional representations that can be folded into three-dimensional figures.		~~one~~a given set of attributes with the volume of a prism where one of the attributes has been increased by a factor of 2, 3, 5 or 10.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students expand the informal experiences they have had with geometry in the elementary grades and develop a solid foundation for the exploration of geometry in high school. Spatial reasoning skills are essential to the formal inductive and deductive reasoning skills required in subsequent mathematics learning.
- Students learn geometric relationships by visualizing, comparing, constructing, sketching, measuring, transforming, and classifying geometric figures. A variety of tools such as geoboards, pattern blocks, dot paper, patty paper, miras, and geometry software provides experiences that help students discover geometric concepts. Students describe, classify, and compare plane and solid figures according to their attributes. They develop and extend understanding of geometric transformations in the coordinate plane.
- Students apply their understanding of perimeter and area from the elementary grades in order to build conceptual understanding of the surface area and volume of prisms, cylinders, pyramids, and cones. They use visualization, measurement, and proportional reasoning skills to develop an understanding of the effect of scale change on distance, area, and volume. They develop and reinforce proportional reasoning skills through the study of similar figures.
- Students explore and develop an understanding of the Pythagorean Theorem. Mastery of the use of the Pythagorean Theorem has far-reaching impact on subsequent mathematics learning and life experiences.

The van Hiele theory of geometric understanding describes how students learn geometry and provides a framework for structuring student experiences that should lead to conceptual growth and understanding.

- **Level 0: Pre-recognition.** Geometric figures are not recognized. For example, students cannot differentiate between three-sided and four-sided polygons.
- **Level 1: Visualization.** Geometric figures are recognized as entities, without any awareness of parts of figures or relationships between components of a figure. Students should recognize and name figures and distinguish a given figure from others that look somewhat the same. (This is the expected level of student performance during grades K and 1.)
- **Level 2: Analysis.** Properties are perceived but are isolated and unrelated. Students should recognize and name properties of geometric figures. (Students are expected to transition to this level during grades 2 and 3.)

- **Level 3: Abstraction.** Definitions are meaningful, with relationships being perceived between properties and between figures. Logical implications and class inclusions are understood, but the role and significance of deduction is not understood. (Students should transition to this level during grades 5 and 6 and fully attain it before taking ~~A~~algebra.)
- **Level 4: Deduction.** Students can construct proofs, understand the role of axioms and definitions, and know the meaning of necessary and sufficient conditions. Students should be able to supply reasons for steps in a proof. (Students should transition to this level before taking ~~G~~geometry.)

8.8 The student will
a) apply transformations to plane figures; and
b) identify applications of transformations.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A rotation of a geometric figure is a clockwise or counterclockwise turn of the figure around a fixed point. The point may or may not be on the figure. The fixed point is called the *center of rotation.* • A reflection of a geometric figure ~~is a flip of the figure~~ moves all of the points of the figure across ~~a line~~ an axis. Each point on the reflected figure is the same distance from the ~~line~~ axis as the corresponding point in the original figure. • A translation of a geometric figure ~~is a slide of the figure in which~~ moves all the points on the figure ~~move~~ the same distance in the same direction. • A dilation of a geometric figure is a transformation that changes the size of a figure by a scale factor to create a similar figure. • ~~Real-life~~ Practical applications may include, but are not limited to, the following: – A rotation of the hour hand of a clock from 2:00 to 3:00 shows a turn of 30° clockwise; – A reflection of a boat in water shows an image of the boat flipped upside down with the water line being the line of reflection~~.~~; – A translation of a ~~shape~~ figure on a wallpaper pattern shows the same ~~shape~~ figure slid the same distance in the same direction~~.~~; and – A dilation of a model airplane is the production model of the airplane. • The image of a polygon is the resulting polygon after a transformation. The preimage is the original polygon before the transformation.	~~**All students should**~~ • ~~Understand the relationship between transformations in a coordinate plane and their application in real-life.~~ • ~~Explain that rotations, reflections, translations and dilations are transformations~~. • How does the transformation of a figure on the coordinate grid affect the congruency, orientation, location and symmetry of an image? Translations, rotations and reflections maintain congruence between the preimage and image but change location. Dilations by a scale factor other than 1 produce an image that is not congruent to the pre-image but is similar. Rotations and reflections change the orientation of the image.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Demonstrate the reflection of a ~~figure~~ polygon over ~~a~~ the vertical or horizontal ~~line~~ axis on a coordinate grid. • Demonstrate 90°, 180°, 270°, and 360° clockwise and counterclockwise rotations of a figure on a coordinate grid. The center of rotation will be limited to the origin. • Demonstrate the translation of a ~~figure~~ polygon on a coordinate grid. • Demonstrate the dilation of a ~~figure~~ polygon from a fixed point on a coordinate grid. • Identify practical applications of transformations including, but not limited~~,~~ to, tiling, fabric, and wallpaper designs, art and scale drawings. • Identify the type of transformation in a given example.

8.8 The student will

a) apply transformations to plane figures; and

b) identify applications of transformations.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A transformation of preimage point A can be denoted as the image A' (read as "A prime").		

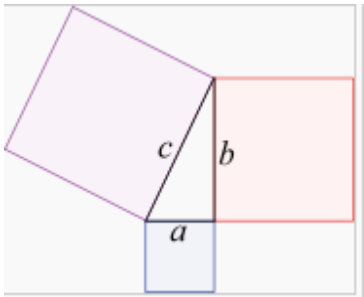
8.9 The student will construct a three-dimensional model, given the top or bottom, side, and front views.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Three-dimensional models of geometric solids can be used to understand perspective and provide tactile experiences in determining two-dimensional perspectives. • Three-dimensional models of geometric solids can be represented on isometric paper. • The top view is a mirror image of the bottom view.	~~**All students should**~~ • How does knowledge of two-dimensional figures inform work with three-dimensional objects? ~~Understand~~ It is important to know that a three-dimensional object can be represented as a two-dimensional model with views of the object from different perspectives.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Construct three-dimensional models, given ~~top, side, and bottom views.~~ the top or bottom, side, and front views. • Identify three-dimensional models given a two-dimensional perspective.

8.10 The student will

a) verify the Pythagorean Theorem; and

b) apply the Pythagorean Theorem.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• In a right triangle, the square of the length of the hypotenuse equals the sum of the squares of the legs (altitude and base). This relationship is known as the Pythagorean Theorem: $a^2 + b^2 = c^2$.  • The Pythagorean Theorem is used to find the measure of any one of the three sides of a right triangle if the measures of the other two sides are known. • Whole number triples that are the measures of the sides of right triangles, such as (3,4,5), (6,8,10), (9,12,15), and (5,12,13), are commonly known as Pythagorean triples. • The hypotenuse of a right triangle is the side opposite the right angle. • The hypotenuse of a right triangle is always the longest side of the right triangle. • The legs of a right triangle form the right angle.	~~**All students should**~~ • How can the area of squares generated by the legs and the hypotenuse of a right triangle be used to verify the Pythagorean theorem? ~~Understand that, f~~ For a right triangle, the area of a square with one side equal to ~~of~~ the measure of the hypotenuse equals the sum of the areas of the squares with one side each equal to the measures of the ~~base and altitude.~~legs of the triangle. • ~~Understand that the Pythagorean Theorem is a tool to find the measure of any side of a right triangle, given the measures of the other two sides.~~ • ~~Demonstrate at least one model of the Pythagorean Theorem.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the parts of a right triangle (the hypotenuse and the legs). • Verify a triangle is a right triangle given the measures of its three sides. • Verify the Pythagorean Theorem, using diagrams, concrete materials, and measurement. • Find the measure of a side of a right triangle, given the measures of the other two sides. ~~The measures of the sides of the triangle may be whole numbers no larger than 15 or decimals in tenths.~~ • Solve ~~real-life~~ practical problems involving right triangles by using the Pythagorean Theorem.

8.11 The student will solve practical area and perimeter problems involving composite plane figures.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A polygon is a simple, closed plane figure with sides that are line segments. • The perimeter of a polygon is the distance around the figure. • The area of any composite figure is based upon knowing how to find the area of the composite parts such as triangles and rectangles. • The area of a rectangle is computed by multiplying the lengths of two adjacent sides. ($A = lw$). • The area of a triangle is computed by multiplying the measure of its base by the measure of its height and dividing the product by 2. ($A = \frac{1}{2}bh$). • The area of a parallelogram is computed by multiplying the measure ~~if~~of its base by the measure of its height ($A = bh$). • The area of a trapezoid is computed by taking the average of the measures of the two bases and multiplying this average by the height. [$A = \frac{1}{2}(b_1 + b_2)h$] • The area of a circle is computed by multiplying Pi times the radius squared ($A = \pi r^2$). • The circumference of a circle is found by multiplying Pi by the diameter or multiplying Pi by 2 times the	~~All students should~~ • How does knowing the areas of polygons assist in calculating the areas of composite figures? The area of a composite figure can be found by subdividing the figure into triangles, rectangles, squares, trapezoids and semi-circles, calculating their areas, and adding the areas together.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Subdivide a figure into triangles, rectangles, squares, trapezoids and~~/or~~ semicircles. Estimate the area of subdivisions and combine to determine the area of the composite figure. ~~Figures will be limited to three subdivisions.~~ • Use the attributes of the subdivisions to determine the perimeter and~~/or~~ circumference of a figure. • Apply perimeter, circumference and~~/or~~ area formulas to solve real-life problems.

8.11 The student will solve practical area and perimeter problems involving composite plane figures.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
radius. ($C = \pi d$ or $C = 2\pi r$). • An estimate of the area of a composite figure can be made by subdividing the polygon into triangles, rectangles, squares, trapezoids and semicircles, estimating their areas, and adding the areas together.		

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students develop an awareness of the power of data analysis and probability by building on their natural curiosity about data and making predictions.
- Students explore methods of data collection and use technology to represent data with various types of graphs. They learn that different types of graphs represent different types of data effectively. They use measures of ~~central tendency~~ center and dispersion to analyze and interpret data.
- Students integrate their understanding of rational numbers and proportional reasoning into the study of statistics and probability.
- Students explore experimental and theoretical probability through experiments and simulations by using concrete, active learning activities.

8.12 The student will determine the probability of independent and dependent events with and without replacement.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Two events are either dependent or independent. • If the outcome of one event does not influence the occurrence of the other event, they are called independent. If events are independent, then the second event occurs regardless of whether or not the first occurs. For example, the first roll of a number cube does not influence the second roll of the number cube. Other examples of independent events are, but not limited to: flipping two coins; spinning a spinner and rolling a number cube; flipping a coin and selecting a card; and choosing a card from a deck, replacing the card and selecting again. • ~~To find the probability of independent events, use the formula: P (A and B) = P(A) · P(B).~~ • The probability of three independent events is found by using the following formula: $P(A\,and\,B\,and\,C) = P(A)\cdot P(B)\cdot P(C)$ Ex: When rolling three number cubes simultaneously, what is the probability of rolling a 3 on one cube, a 4 on one cube, and a 5 on the third? $P(3\,and\,4\,and\,5) = P(3)\cdot P(4)\cdot P(5) = \frac{1}{6}\cdot\frac{1}{6}\cdot\frac{1}{6} = \frac{1}{216}$ • If the outcome of one event has an impact on the outcome of the other event, the events are called dependent. If events are dependent then the second event is considered only if the first event has already occurred. For example, if you are dealt a King from a deck of cards and you do not place the King back into the deck before selecting a second card, the chance of selecting a King the second time is	~~**All students should**~~ • How are the probabilities of dependent and independent events similar? Different? If events are dependent then the second event is considered only if the first event has already occurred. If events are independent, then the second event occurs regardless of whether or not the first occurs.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine the probability of no more than ~~3~~ three independent events ~~with replacement~~. • Determine the probability of no more than ~~2~~ two dependent events without replacement. • Compare the outcomes of events with and without replacement.

8.12 The student will determine the probability of independent and dependent events with and without replacement.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
diminished because there are now only three Kings remaining in the deck. Other examples of dependent events are, but not limited to: choosing two marbles from a bag but not replacing the first after selecting it; and picking a sock out of a drawer and then picking a second sock without replacing the first. • The probability of two dependent events is found by using the following formula: $P(A \text{ and } B) = P(A) \cdot P(B \text{ after } A)$ Ex: You have a bag holding a blue ball, a red ball, and a yellow ball. What is the probability of picking a blue ball out of the bag on the first pick then *without* replacing the blue ball in the bag, picking a red ball on the second pick? $P(\text{blue } \textit{and} \text{ red}) = P(\text{blue}) \cdot P(\text{red } \textit{after} \text{ blue}) = \frac{1}{3} \cdot \frac{1}{2} = \frac{1}{6}$ ~~• To find the probability of dependent events, use the formula: P (B/A) = P (A) • P (A/B).~~		

8.13 The student will

a) make comparisons, predictions, and inferences, using information displayed in graphs; and

b) construct and analyze scatterplots.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Comparisons, predictions, and inferences are made by examining characteristics of a data set displayed in a variety of graphical representations to draw conclusions. • The information displayed in different graphs may be examined to determine how data are or are not related, ascertaining differences between characteristics (comparisons), trends that suggest what new data might be like (predictions), and/or "what could happen if" (inferences). • A scatterplot illustrates the relationship between two sets of data. A scatterplot consists of points. The coordinates of the point represent the measures of the two attributes of the point. • Scatterplots can be used to predict trends and estimate a line of best fit. • In a scatterplot, each point is represented by an independent and dependent variable. The independent variable is graphed on the horizontal axis and the dependent is graphed on the vertical axis.	~~**All students should**~~ • Why do we estimate a line of best fit for a scatterplot? A line of best fit helps in making interpretations and predictions about the situation modeled in the data set. • What are the inferences that can be drawn from sets of data points having a positive relationship, a negative relationship, and no relationship? Sets of data points with positive relationships demonstrate that the values of the two variables are increasing. A negative relationship indicates that as the value of the independent variable increases, the value of the dependent variable decreases.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Make comparisons, predictions, and inferences, given data sets of no more than 20 items that are displayed in frequency distributions; box-and-whisker plots; scatterplots; line, bar, circle, and picture graphs; and histograms.~~ • Collect, organize and interpret a data set of no more than 20 items using scatterplots. Predict from the trend an estimate of the line of best fit with a drawing. • Interpret the set of data points in a scatterplot as having a positive relationship, a negative relationship, or no relationship.

In the middle grades, the focus of mathematics learning is to

- build on students' concrete reasoning experiences developed in the elementary grades;
- construct a more advanced understanding of mathematics through active learning experiences;
- develop deep mathematical understandings required for success in abstract learning experiences; and
- apply mathematics as a tool in solving ~~real-life~~ practical problems.

Students in the middle grades use problem solving, mathematical communication, mathematical reasoning, connections, and representations to integrate understanding within this strand and across all the strands.

- Students extend their knowledge of patterns developed in the elementary grades and through life experiences by investigating and describing functional relationships.
- Students learn to use algebraic concepts and terms appropriately. These concepts and terms include *variable, term, coefficient, exponent, expression, equation, inequality, domain*, and *range*. Developing a beginning knowledge of algebra is a major focus of mathematics learning in the middle grades.
- Students learn to solve equations by using concrete materials. They expand their skills from one-step to two-step equations and inequalities.
- Students learn to represent relations by using ordered pairs, tables, rules, and graphs. Graphing in the coordinate plane linear equations in two variables is a focus of the study of functions.

8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.

UNDERSTANDING THE STANDARD (Background Information for Instructor Use Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A relation is any set of ordered pairs. For each first member ~~(domain)~~, there may be many second members ~~(range)~~. • A function is a relation in which there is one and only one second member ~~(range)~~ for each first member ~~(domain)~~. • As a table of values, a function has a unique value assigned to the second variable ~~(range)~~ for each value of the first variable ~~(domain)~~. • As a graph, a function is any curve (including straight lines) such that any vertical line would pass through the curve only once. • Some relations are functions; all functions are relations. • Graphs of functions can be discrete or continuous. • In a discrete function graph there are separate, distinct points. You would not use a line to connect these points on a graph. The points between the plotted points have no meaning and cannot be interpreted. • In a graph of continuous function every point in the domain can be interpreted therefore it is possible to connect the points on the graph with a continuous line as every point on the line answers the original question being asked. • Functions can be represented as tables, graphs, equations, physical models, or in words.	~~**All students should**~~ ~~• Understand the difference between functions and relations.~~ ~~• Understand that a function is a one-to-one relationship between the domain and range.~~ • What is the relationship among tables, graphs, words, and ~~equations~~rules in modeling a given situation? Any given ~~function~~relationship can be represented by all ~~three~~four.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Graph in a coordinate plane ordered pairs that represent a relation. ~~• Write a rule that represents a relation from a table of values.~~ ~~• Write a table of values from the rule that represents a relation.~~ ~~• Write a table of values from the graph of ordered pairs of a relation.~~ • Describe and represent relations and functions, using tables, graphs, words, and ~~rules~~rules ~~equations~~. Given one representation students will be able to represent the relation in another form. • Relate and compare different representations for the same relation.

8.15 The student will

a) solve multistep linear equations in one variable on one and two sides of the equation;
b) solve two-step linear inequalities and graph the results on a number line; and
c) identify properties of operations used to solve an equation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A multistep equation is an equation that requires more than one different mathematical operation to solve. • A two-step inequality is defined as an inequality that requires the use of two different operations to solve (e.g., $3x - 4 > 9$). • In an equation, the equal sign indicates that the value on the left is the same as the value on the right. • To maintain equality, an operation that is performed on one side of an equation must be performed on the other side. • When both expressions of an inequality are multiplied or divided by a negative number, the inequality sign reverses. • The commutative property for addition states that changing the order of the addends does not change the sum (e.g., $5 + 4 = 4 + 5$). • The commutative property for multiplication states that changing the order of the factors does not change the product (e.g., $5 \cdot 4 = 4 \cdot 5$). • The associative property of addition states that regrouping the addends does not change the sum [e.g., $5 + (4 + 3) = (5 + 4) + 3$]. • The associative property of multiplication states that regrouping the factors does not change the product [e.g., $5 \cdot (4 \cdot 3) = (5 \cdot 4) \cdot 3$].	~~**All students should**~~ • ~~Understand that an operation that is performed on one side of an equation must be performed on the other side to maintain equality.~~ • ~~Understand that when both expressions are multiplied or divided by a negative number, the inequality symbol reverses.~~ • How does the solution to an equation differ from the solution to an inequality? While a linear equation has only one replacement value for the variable that makes the equation true, an inequality can have more than one.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Solve two- to four- step linear equations in one variable ~~by showing the steps and using algebraic sentences.~~using concrete materials, pictorial representations and paper and pencil illustrating the steps performed. • Solve two-step inequalities in one variable by showing the steps and using algebraic sentences. • Graph solutions to two-step linear inequalities on a number line. • Identify properties of operations used to solve an equation from among: - the commutative properties of addition and multiplication; - the associative properties of addition and multiplication; - the distributive property; - the identity properties of addition and multiplication; - the zero property of multiplication; - the additive inverse property; and - the multiplicative inverse property.

8.15 The student will

a) solve multistep linear equations in one variable on one and two sides of the equation;
b) solve two-step linear inequalities and graph the results on a number line; and
c) identify properties of operations used to solve an equation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Subtraction and division are neither commutative nor associative. • The distributive property states that the product of a number and the sum (or difference) of two other numbers equals the sum (or difference) of the products of the number and each other number [e.g., $5 \cdot (3 + 7) = (5 \cdot 3) + (5 \cdot 7)$, or $5 \cdot (3 - 7) = (5 \cdot 3) - (5 \cdot 7)$]. • Identity elements are numbers that combine with other numbers without changing the other numbers. The additive identity is zero (0). The multiplicative identity is one (1). There are no identity elements for subtraction and division. • The additive identity property states that the sum of any real number and zero is equal to the given real number (e.g., $5 + 0 = 5$). • The multiplicative identity property states that the product of any real number and one is equal to the given real number (e.g., $8 \cdot 1 = 8$). Inverses are numbers that combine with other numbers and result in identity elements [e.g., $5 + (-5) = 0$; $\frac{1}{5} \cdot 5 = 1$]. • The additive inverse property states that the sum of a number and its additive inverse always equals zero [e.g., $5 + (-5) = 0$]. • The multiplicative inverse property states that the product of a number and its multiplicative inverse (or reciprocal) always equals one (e.g., $4 \cdot \frac{1}{4} = 1$).		

8.15 The student will

a) solve multistep linear equations in one variable on one and two sides of the equation;
b) solve two-step linear inequalities and graph the results on a number line; and
c) identify properties of operations used to solve an equation.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Zero has no multiplicative inverse. • The multiplicative property of zero states that the product of any real number and zero is zero. • Division by zero is not a possible arithmetic operation. • Combining like terms means to combine terms that have the same variable and the same exponent (e.g., $8x + 11 – 3x$ can be $5x +11$ by combining the like terms of $8x$ and $-3x$).		

8.16 The student will graph a linear equation in two variables.

UNDERSTANDING THE STANDARD (Background Information for Instructor Only)	ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A linear equation is an equation in two variables whose graph is a straight line, a type of continuous function (see SOL 8.14). • A linear equation represents a situation with a constant rate. For example, when driving at a rate of 35 mph, the distance increases as the time increases, but the rate of speed remains the same. • Graphing a linear equation requires determining a table of ordered pairs by substituting into the equation values for one variable and solving for the other variable, plotting the ordered pairs in the coordinate plane, and connecting the points to form a straight line. • The axes of a coordinate plane are generally labeled *x* and *y*; however, any letters may be used that are appropriate for the function.	~~**All students should**~~ • ~~Understand that the graph of a linear equation in two variables is the set of all ordered pairs that satisfy the equation.~~ • What types of real life situations can be represented with linear equations? Any situation with a constant rate can be represented by a linear equation.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Construct a table of ordered pairs by substituting values for *x* in a linear equation to find values for *y*. • Plot in the coordinate plane ordered pairs (*x*, *y*) from a table. • Connect the ordered pairs to form a straight line (a continuous function).

8.17 The student will identify the domain, range, independent variable or dependent variable in a given situation.

UNDERSTANDING THE STANDARD
(Background Information for Instructor Only)

- The domain is the ~~possible~~ set of all the input values for the independent variable in a given situation.
- The range is the ~~possible~~ set of all the output values for the dependent variable in a given situation.
- The independent variable is the input value.
- The dependent variable depends on the independent variable and is the output value.
- Below is a table of values for finding the circumference of circles, $C = \pi d$, where the value of π is approximated as 3.14.

Diameter	Circumference
1 in.	3.14 in.
2 in.	6.28 in.
3 in.	9.42 in.
4 in.	12.56 in.

- The independent variable, or input, is the diameter of the circle. The values for the diameter make up the domain.
- The dependent variable, or output, is the circumference of the circle. The set of values for the circumference makes up the range.

ESSENTIAL UNDERSTANDINGS

~~**All students should**~~

- ~~Understand that the domain represents all the values for the independent variables and the range represents all the values for the dependent variables.~~
- ~~Understand that the independent variable is the value that causes the change in the dependent variable and the dependent variable is affected by the independent variable.~~
- What are the similarities and differences among the terms domain, range, independent variable and dependent variable?
  The value of the dependent variable changes as the independent variable changes. The domain is the set of all input values for the independent variable. The range is the set of all possible values for the dependent variable.

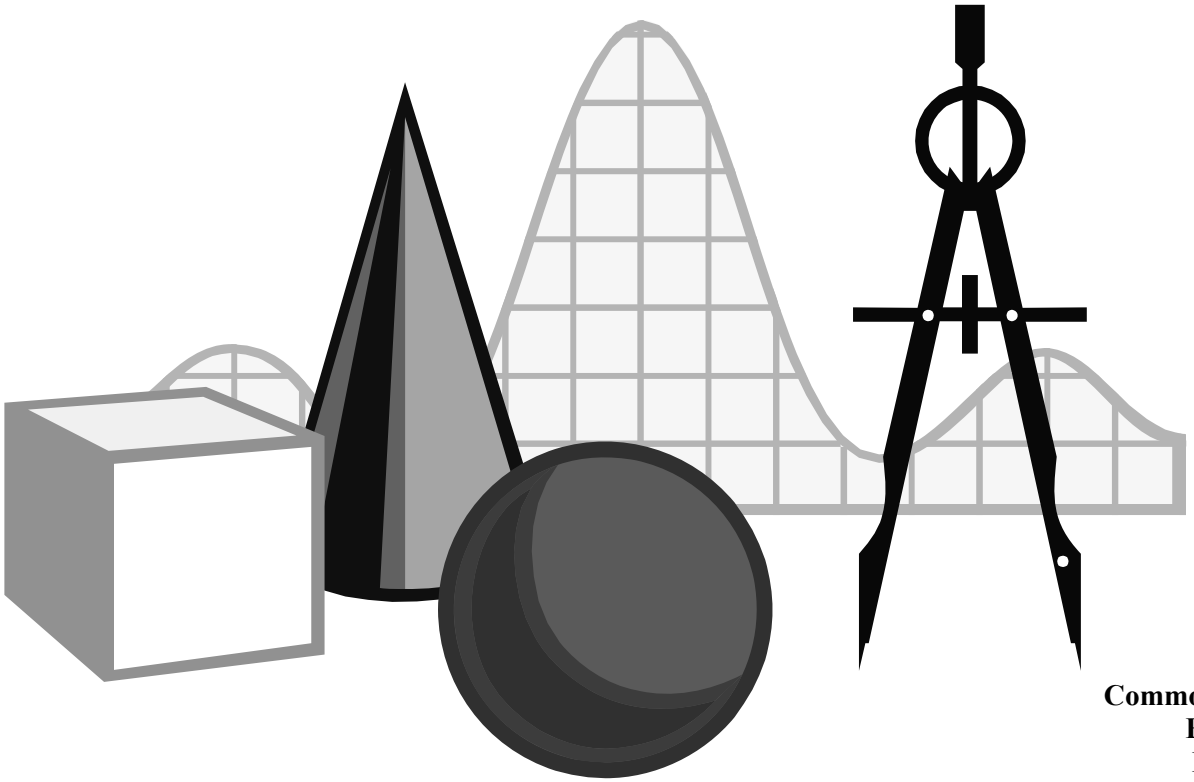
ESSENTIAL KNOWLEDGE AND SKILLS

The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to

- Apply the following algebraic terms appropriately: *domain*, *range*, *independent variable*, and *dependent variable.*
- Identify examples of domain, range, independent variable, and dependent variable.
- Determine the domain of a function.
- Determine the range of a function.
- Determine the independent variable of a relationship.
- Determine the dependent variable of a relationship.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Algebra I



Commonwealth of Virginia
Board of Education
Richmond, Virginia
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The Virginia Department of Education does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities.

The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into two columns: Essential Understandings and Essential Knowledge and Skills ~~and Essential Understandings~~. The purpose of each column is explained below.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

TOPIC: EXPRESSIONS AND OPERATIONS

ALGEBRA I
STANDARD A.1

The student will represent verbal quantitative situations algebraically and evaluate these expressions for given replacement values of the variables.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Algebra is a tool for reasoning about quantitative situations so that relationships become apparent. • Algebra is a tool for describing and representing patterns and relationships. • Mathematical modeling involves creating algebraic representations of quantitative real-world situations. • The numerical value of an expression is dependent upon the values of the replacement set for the variables. • There are a variety of ways to compute the value of a numerical expression and evaluate an algebraic expression. • The operations and the magnitude of the numbers in an expression impact the choice of an appropriate ~~method of computation~~ computational technique. • An appropriate computational technique could be mental mathematics, calculator, or paper and pencil.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Translate verbal quantitative situations ~~expressions~~ into algebraic expressions and vice versa ~~with three or fewer terms~~. • ~~Relate a polynomial expression with three or fewer terms to a verbal expression.~~ • Model real-world situations with algebraic expressions in a variety of representations (concrete, pictorial, symbolic, verbal). • Evaluate algebraic expressions for a given replacement set to include ~~integers and~~ rational numbers. • ~~Apply appropriate computational techniques to evaluate an algebraic expression.~~ • Evaluate expressions that contain absolute value, square roots, and cube roots.

TOPIC: EXPRESSIONS AND OPERATIONS

ALGEBRA I
STANDARD A.2

The student will perform operations on polynomials, including

a) applying the laws of exponents to perform operations on expressions;
b) adding, subtracting, multiplying, and dividing polynomials; and
c) factoring completely first- and second-degree binomials and trinomials in one or two variables. Graphing calculators will be used as a tool for factoring and for confirming algebraic factorizations.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Repeated multiplication can be represented with exponents.~~ • The laws of exponents can be investigated using ~~patterns~~ inductive reasoning. • ~~The base and the exponent impact the magnitude of the expression.~~ • A relationship exists between the laws of exponents and scientific notation. • ~~A relationship exists between arithmetic operations and operations with polynomials.~~ • ~~Polynomials can be represented in a variety of forms.~~ • Operations with polynomials can be represented concretely, pictorially, and ~~algebraically~~ symbolically. • Polynomial expressions can be used to model real-~~life~~ world situations. • The distributive property is the unifying concept for polynomial	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify the base, exponent, and coefficient in a monomial expression.~~ • Simplify monomial expressions and ratios of monomial expressions in which the exponents are integers, using the laws of exponents. • ~~Express numbers, using scientific notation, and perform operations, using the laws of exponents.~~ • Model sums, differences, products, and quotients of polynomials with concrete objects and their related pictorial representations. • Relate concrete and pictorial ~~representations for~~ manipulations that model polynomial operations to their corresponding ~~algebraic manipulations~~ symbolic representations. • Find sums and differences of polynomials. • Find products of polynomials. The factors will have no more than five total terms. (i.e. (4x+2)(3x+5) represents four terms and

TOPIC: EXPRESSIONS AND OPERATIONS

ALGEBRA I
STANDARD A.2

The student will perform operations on polynomials, including

a) applying the laws of exponents to perform operations on expressions;
b) adding, subtracting, multiplying, and dividing polynomials; and
c) factoring completely first- and second-degree binomials and trinomials in one or two variables. Graphing calculators will be used as a tool for factoring and for confirming algebraic factorizations.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
operations. • Factoring reverses polynomial multiplication. • Some polynomials are prime polynomials and cannot be factored over the set of real numbers. • Polynomial expressions ~~in a variable *x* and their factors~~ can be used to define functions ~~by setting *y* equal to the polynomial expression or *y* equal to a factor,~~ and these functions can be represented graphically. • There is a relationship between the factors of ~~a~~ any polynomial and the *x*-intercepts of ~~its related~~ the graph of its related function.	$(x+1)(2x^2+x+3)$ represents five terms) • ~~Multiply polynomials by monomials and binomials by binomials symbolically.~~ • Find the quotient of polynomials, using a monomial or binomial divisor, or a completely factored divisor. • ~~Use the distributive property to "factor out" all common monomial factors.~~ • Factor completely first- and second-degree polynomials ~~and binomials~~ with integral coefficients ~~and a positive leading coefficient less than four~~. • Identify prime polynomials ~~that cannot be factored over the set of real numbers~~. • Use the *x*-intercepts from the graphical representation of the polynomial to determine and confirm its factors.

TOPIC: EXPRESSIONS AND OPERATIONS

ALGEBRA I
STANDARD A.3

The student will express the square roots and cube roots of whole numbers and the square root of a monomial algebraic expression in simplest radical form.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~The square root of a perfect square is an integer.~~ • ~~The square root of a non-perfect square lies between two consecutive integers.~~ • ~~The inverse of squaring a number is determining the square root.~~ • A ~~radical~~ square root in simplest form is one in which the radicand (argument) has no perfect square factors other than one. • A cube root in simplest form is one in which the argument has no perfect cube factors other than one. • ~~The square root of a product is the product of the square roots.~~ • The cube root of a perfect cube is an integer. • The cube root of a nonperfect cube lies between two consecutive integers. • The inverse of cubing a number is determining the cube root. • In the real number system, the argument of a square root must be nonnegative while the argument of a cube root may be any real number.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Estimate the square root of a non-perfect square to the nearest tenth by~~ ~~– identifying the two perfect squares it lies between;~~ ~~– finding the square root of those two perfect squares; and~~ ~~– using those values to estimate the square root of the non-perfect square.~~ • ~~Find the square root of a number, and make a reasonable interpretation of the displayed value for a given situation, using a calculator.~~ • Express ~~the~~ square roots of a whole number ~~less than 1,000~~ in simplest ~~radical~~ form. • Express the cube root of a whole number in simplest form. • Express the principal square root of a monomial algebraic expression in simplest form where variables are assumed to have positive values.

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.4

The student will solve multistep linear and quadratic equations in two variables, including

a) solving literal equations (formulas) for a given variable;
b) justifying steps used in simplifying expressions and solving equations, using field properties and axioms of equality that are valid for the set of real numbers and its subsets;
c) solving quadratic equations algebraically and graphically;
d) solving multistep linear equations algebraically and graphically;
e) solving systems of two linear equations in two variables algebraically and graphically; and
f) solving real-world problems involving equations and systems of equations.

Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A solution to an equation is the value or set of values that can be substituted to make the equation true. • ~~Equations can be solved in a variety of ways.~~ • The solution of an equation in one variable can be found by graphing the expression on each ~~side~~side ~~member~~ of the equation separately and finding the *x*-coordinate of the point of intersection. • ~~Practical~~ Real-world problems can be interpreted, represented, and solved using linear and quadratic equations ~~and inequalities in one variable~~. • The ~~representation and manipulation~~ process of solving ~~expressions,~~ linear and quadratic equations~~, and inequalities~~ can be modeled in a variety of ways, using concrete, pictorial, and symbolic representations. • Properties of real numbers and properties of equality can be used	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Translate verbal sentences to algebraic equations in one variable.~~ • Solve a literal equation (formula) for a specified variable. • Simplify expressions and solve equations, using the ~~commutative, associative, and distributive~~ field properties of the real numbers and properties of equality to justify simplification and solution. • Solve quadratic equations. ~~algebraically or by using the graphing calculator~~. ~~When solutions are represented in radical form, the decimal approximation will also be given.~~ • Identify the ~~*x*-intercepts~~ roots or zeros of ~~the~~ a quadratic function over the real number system as the solution(s) to the quadratic equation that is formed by setting the given quadratic expression equal to zero. • Solve multistep linear equations in one variable. ~~in one variable~~

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.4

The student will solve multistep linear and quadratic equations in two variables, including

a) solving literal equations (formulas) for a given variable;
b) justifying steps used in simplifying expressions and solving equations, using field properties and axioms of equality that are valid for the set of real numbers and its subsets;
c) solving quadratic equations algebraically and graphically;
d) solving multistep linear equations algebraically and graphically;
e) solving systems of two linear equations in two variables algebraically and graphically; and
f) solving real-world problems involving equations and systems of equations.

Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
to justify equation solutions and expression simplification. • The zeros or the *x*-intercepts of the quadratic function are the real root(s) or solution(s) of the quadratic equation that is formed by setting the given quadratic expression equal to zero. • ~~Justifications will include the use of concrete objects; pictorial representations.~~ • A system of linear equations with exactly one solution is characterized by the graphs of two lines whose intersection is a single point, and the coordinates of this point satisfy both equations. • ~~A point shared by two intersecting graphs and the ordered pair that satisfies the equations characterize a system of equations with only one solution.~~ • A system of two linear equations with no solution is characterized by the graphs of two lines that are parallel.	~~with the variable in both sides of the equation or inequality.~~ • ~~Solve multistep linear equations in one variable with grouping symbols in one or both sides of the equation or inequality.~~ • ~~Solve multistep equations in one variable with rational coefficients and constants.~~ • ~~Apply skills for solving linear equations to practical situations.~~ • Confirm algebraic solutions to linear and quadratic equations, using a graphing calculator. • ~~Simplify expressions and solve equations and inequalities, using the order of operations.~~ • Given a system of two linear equations in two variables that has a unique solution, solve the system by substitution or elimination to find the ordered pair which satisfies both equations. • Given a system of two linear equations in two variables that has a

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.4

The student will solve multistep linear and quadratic equations in two variables, including

a) solving literal equations (formulas) for a given variable;
b) justifying steps used in simplifying expressions and solving equations, using field properties and axioms of equality that are valid for the set of real numbers and its subsets;
c) solving quadratic equations algebraically and graphically;
d) solving multistep linear equations algebraically and graphically;
e) solving systems of two linear equations in two variables algebraically and graphically; and
f) solving real-world problems involving equations and systems of equations.

Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A system of two linear equations having infinite solutions is characterized by two graphs that coincide (the graphs will appear to be the graph of one line), and ~~all~~ the coordinates of all points on ~~this one~~ the line satisfy both equations. • Systems of two linear equations can be used to model two real-world conditions that must be satisfied simultaneously. • ~~Quadratic equations can be solved in a variety of ways.~~ • ~~A quadratic equation can have two solutions, one solution, or no solution.~~ • ~~A solution to a quadratic equation is the value or set of values that can be substituted to make the equation true.~~ • Equations and systems of equations can be used as mathematical models for real-world situations. • Set builder notation may be used to represent solution sets of	unique solution, solve the system graphically ~~to find~~ by identifying the point of intersection. • Determine whether a system of two linear equations has one solution, no solution, or infinite solutions. • Write a system of two linear equations that ~~describes~~ models a ~~practical~~ real-world situation. • Interpret and determine the reasonableness of the algebraic or graphical solution of a system of two linear equations that ~~describes~~ models a ~~practical~~ real-world situation. • ~~Verify algebraic solutions, using the graphing calculator.~~

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.4

The student will solve multistep linear and quadratic equations in two variables, including

a) **solving literal equations (formulas) for a given variable;**
b) **justifying steps used in simplifying expressions and solving equations, using field properties and axioms of equality that are valid for the set of real numbers and its subsets;**
c) **solving quadratic equations algebraically and graphically;**
d) **solving multistep linear equations algebraically and graphically;**
e) **solving systems of two linear equations in two variables algebraically and graphically; and**
f) **solving real-world problems involving equations and systems of equations.**

Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
equations ~~and inequalities~~.	

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.5

The student will solve multistep linear inequalities in two variables, including

a) solving multistep linear inequalities algebraically and graphically;
b) justifying steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers and its subsets;
c) solving real-world problems involving inequalities; and
d) solving systems of inequalities.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A solution to an inequality is the value or set of values that can be substituted to make the inequality true. • ~~Inequalities can be solved in a variety of ways.~~ • ~~Practical~~ Real-world problems can be ~~interpreted, represented,~~ modeled and solved using linear inequalities ~~in one variable~~. • Properties of inequality and order can be used to solve inequalities. • Set builder notation may be used to represent solution sets of inequalities.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Translate verbal sentences to algebraic inequalities in one variable.~~ • Solve multistep ~~noncompound~~ linear inequalities ~~in one variable~~ in one variable~~with the variable in both sides of the equation or inequality~~. • ~~Solve multistep linear inequalities in one variable with grouping symbols in one or both sides of the inequality.~~ • ~~Solve multistep inequalities in one variable with rational coefficients and constants.~~ • ~~Confirm algebraic solutions to linear inequalities, using a graphing calculator.~~ • Justify steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers.

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.5

The student will solve multistep linear inequalities in two variables, including

a) solving multistep linear inequalities algebraically and graphically;
b) justifying steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers and its subsets;
c) solving real-world problems involving inequalities; and
d) solving systems of inequalities.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
	• ~~Simplify expressions and solve inequalities, using the commutative, associative, and distributive properties.~~ • ~~Simplify expressions and solve inequalities, using the order of operations.~~ • ~~Create and interpret pictorial representations for simplifying expressions and solving equations and inequalities.~~ • Solve systems of linear inequalities algebraically and graphically.

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.6

The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and

b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Linear functions and inequalities can be written in a variety of forms.~~ • ~~Linear functions and inequalities can be graphed, using a variety of techniques.~~ • ~~An appropriate technique for graphing linear functions and inequalities can be determined by the given information and/or the tools available.~~ • Changes in slope may be described by dilations or reflections or both. • Changes in the y-intercept may be described by translations. • ~~Justification of an appropriate technique for graphing linear equations and inequalities is dependent upon the application of slope, *x*- and *y*-intercepts, and graphing by transformations.~~ • Linear equations can be graphed using slope, x- and y-intercepts, and/or transformations of the parent function. • The slope of a ~~linear function~~ line represents a constant rate of change in the dependent variable when the independent variable	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Graph linear equations and inequalities in two variables, including those that arise from a variety of ~~practical~~ real-world situations. • Use the ~~line~~ parent function $y = x$ ~~as a reference,~~ and ~~apply~~ describe transformations defined by changes in the slope or *y*-intercept. • ~~Express linear functions or inequalities in slope-intercept form, and use the graphing calculator to display the relationship.~~ • ~~Explain why a given technique is appropriate for graphing a linear function.~~ • ~~Recognize that *m* represents the slope in the equation of the form $y = mx + b$.~~ • Find the slope of the line, given the equation of a linear function. • ~~Calculate~~ Find the slope of a line, given the coordinates of two points on the line.

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.6

The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and

b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
changes by a ~~fixed~~ constant amount. • ~~The slope of a line determines its relative steepness~~. • ~~The slope of a line can be determined in a variety of ways.~~ • ~~Changes in slope affect the graph of a line.~~ • The equation of a line defines the relationship between two variables. • The graph of a line represents the set of points that satisfies the equation of a line. • A line can be represented by its graph or by an equation. • ~~The equation of a line can be determined by two points on the line or by the slope and a point on the line.~~ • The graph of the solutions of a linear inequality is a half-plane bounded by the graph of its related linear equation. Points on the boundary are included unless it is a strict inequality. • Parallel lines have equal slopes. • The product of the slopes of perpendicular lines is -1 unless one	• Find the slope of a line, given the graph of a line. • Recognize and describe a line with a slope that is positive, negative, zero, or undefined. • ~~Compare the slopes of graphs of linear functions, using the graphing calculator.~~ • ~~Describe slope as a constant rate of change between two variables.~~ • Use transformational graphing to investigate effects of changes in equation parameters on the graph of the equation. • ~~Recognize that equations of the form $y = mx + b$ and $Ax + By = C$ are equations of lines.~~ • Write an equation of a line when given the graph of a line. • Write an equation of a line when given two points on the line whose coordinates are integers. • Write an equation of a line when given the slope and a point on the line whose coordinates are integers.

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA I
STANDARD A.6

The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and

b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
of the lines has an undefined slope.	• Write an equation of a vertical line as x =a. • Write the equation of a horizontal line as $y = c$.

TOPIC: FUNCTIONS

ALGEBRA I
STANDARD A.7

The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including

a) determining whether a relation is a function;
b) domain and range;
c) zeros of a function;
d) *x*- and *y*-intercepts;
e) finding the values of a function for elements in its domain; and
f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A set of data may be characterized by patterns, and those patterns can be represented in multiple ways. • Graphs can be used as visual representations to investigate relationships between quantitative data. • ~~Algebra is a tool for describing patterns, making generalizations, and representing a relationship in which output is related to input.~~ • Inductive reasoning may be used to make conjectures about characteristics of function families. • ~~A function is a relation for which there is a unique output for each input.~~ • ~~A relation can be represented by a set of ordered pairs.~~ • Each element in the domain of a relation is the abscissa of a point of the graph of the relation.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Analyze a table of ordered pairs for the existence of a pattern that defines the change relating input and output values.~~ • ~~Write a linear equation to represent a pattern in which there is a constant rate of change between variables.~~ • Determine ~~from~~whether a relation, represented by a set of ordered pairs, a table, or a graph~~ whether a relation~~ is a function. • Identify the domain, range, zeros, and intercepts of a function presented algebraically or graphically. • ~~Identify the domain and range for a relation, given a set of ordered pairs, a table, or a graph.~~ • ~~Use physical representations, such as algebra manipulatives, to~~

TOPIC: FUNCTIONS

ALGEBRA I
STANDARD A.7

The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including

a) determining whether a relation is a function;
b) domain and range;
c) zeros of a function;
d) *x*- and *y*-intercepts;
e) finding the values of a function for elements in its domain; and
f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Each element in the range of a relation is the ordinate of a point of the graph of the relation. • ~~The domain consists of the first coordinates of the ordered pairs.~~ • ~~The range consists of the second coordinates of the ordered pairs.~~ • A relation is a function if and only if each element in the domain is paired with a unique element of the range. • ~~An equation represents the relationship between the independent and dependent variables.~~ • The values of $f(x)$ are the ordinates of the points of the graph of f. • The object $f(x)$ is the unique object in the range of the function f that is associated with the object x in the domain of f. • For each x in the domain of f, x is a member of the input of the function f, $f(x)$ is a member of the output of f, and the ordered pair	~~represent quantitative data.~~ • For each x in the domain of f, find $f(x)$. • ~~Identify the zeros of the function algebraically and confirm them, using the graphing calculator~~. • Detect patterns in data and represent arithmetic and geometric patterns algebraically. • ~~Detect departures from patterns in data.~~

TOPIC: FUNCTIONS

ALGEBRA I
STANDARD A.7

The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including

a) determining whether a relation is a function;
b) domain and range;
c) zeros of a function;
d) *x*- and *y*-intercepts;
e) finding the values of a function for elements in its domain; and
f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
$[x, f(x)]$ is a member of f. • An object x in the domain of f is an x-intercept or a zero of a function f if and only if $f(x) = 0$. • <u>Set builder notation may be used to represent domain and range of a relation.</u>	

TOPIC: FUNCTIONS

ALGEBRA I
STANDARD A.8

The student, given a situation in a real-world context, will analyze a relation to determine whether a direct or inverse variation exists, and represent a direct variation algebraically and graphically and an inverse variation algebraically.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The constant of proportionality ~~k~~ in a direct variation is represented by the ratio of ~~y to x~~ the dependent variable to the independent variable ~~($k = \frac{y}{x}$), where y is the dependent variable~~. • The constant of proportionality in an inverse variation is represented by the product of the dependent variable and the independent variable. • ~~Direct variation is used to represent a constant rate of change in practical applications.~~ • A direct variation can be represented by a line passing through the origin. • ~~In direct variation, equal changes in x result in proportional changes in y.~~ • Real-world problems may be modeled using direct and/or inverse variations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Given a situation, including a real-world situation, ~~table of values,~~ determine whether a direct variation exists. • Given a situation, including a real-world situation, determine whether an inverse variation exists. • Write an equation for a direct variation, given a set of data. • Write an equation for an inverse variation, given a set of data. • ~~Graph a direct variation from a table of values or a practical situation.~~ • Graph an equation representing a direct variation, given a set of data.

TOPIC: STATISTICS

ALGEBRA I
STANDARD A.9

The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute deviation, standard deviation, and z-scores.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Descriptive statistics may include measures of center and ~~variation~~dispersion. • Variance, standard deviation, and mean absolute deviation ~~may be used to~~ measure the ~~variability~~dispersion of the data. • The sum of the deviations of data points from the mean of a data set is 0. • Standard deviation is expressed in the original units of measurement of the data. • Standard deviation addresses the dispersion of data about the mean. • Standard deviation is calculated by taking the square root of the variance. • The greater the value of the standard deviation, the further the data tend to be dispersed from the mean. • For a data distribution with outliers, the mean absolute deviation may be a better measure of dispersion than the standard deviation or variance. • A z-score (standard score) is a measure of position derived from the mean and standard deviation of data.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Analyze descriptive statistics to determine the implications for the real-world situations from which the data derive. • Given data, including data in a real-world context, calculate and interpret the mean absolute deviation of a data set. • Given data, including data in a real-world context, calculate variance and standard deviation of a data set and interpret the ~~variance and~~ standard deviation. • Given data, including data in a real-world context, calculate and interpret z-scores for a data set~~the data~~. • Explain ways in which standard deviation addresses dispersion by examining the formula for standard deviation. • Compare and contrast mean absolute deviation and standard deviation in a real-world context.

TOPIC: STATISTICS

ALGEBRA I
STANDARD A.9

The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute deviation, standard deviation, and z-scores.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A z-score derived from a particular data value tells how many standard deviations that data value is above or below the mean of the data set. It is positive if the data value lies above the mean, and negative if the data value lies below the mean.	

TOPIC: STATISTICS

ALGEBRA I
STANDARD A.10

The student will compare and contrast multiple univariate data sets, using box-and-whisker plots.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Statistical techniques can be used to organize, display, and compare sets of data. • Box-and-whisker plots can be used to analyze data.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare, contrast, and analyze ~~two sets of~~ data, including data from real-world situations ~~using~~ displayed in box-and-whisker plots.

TOPIC: STATISTICS

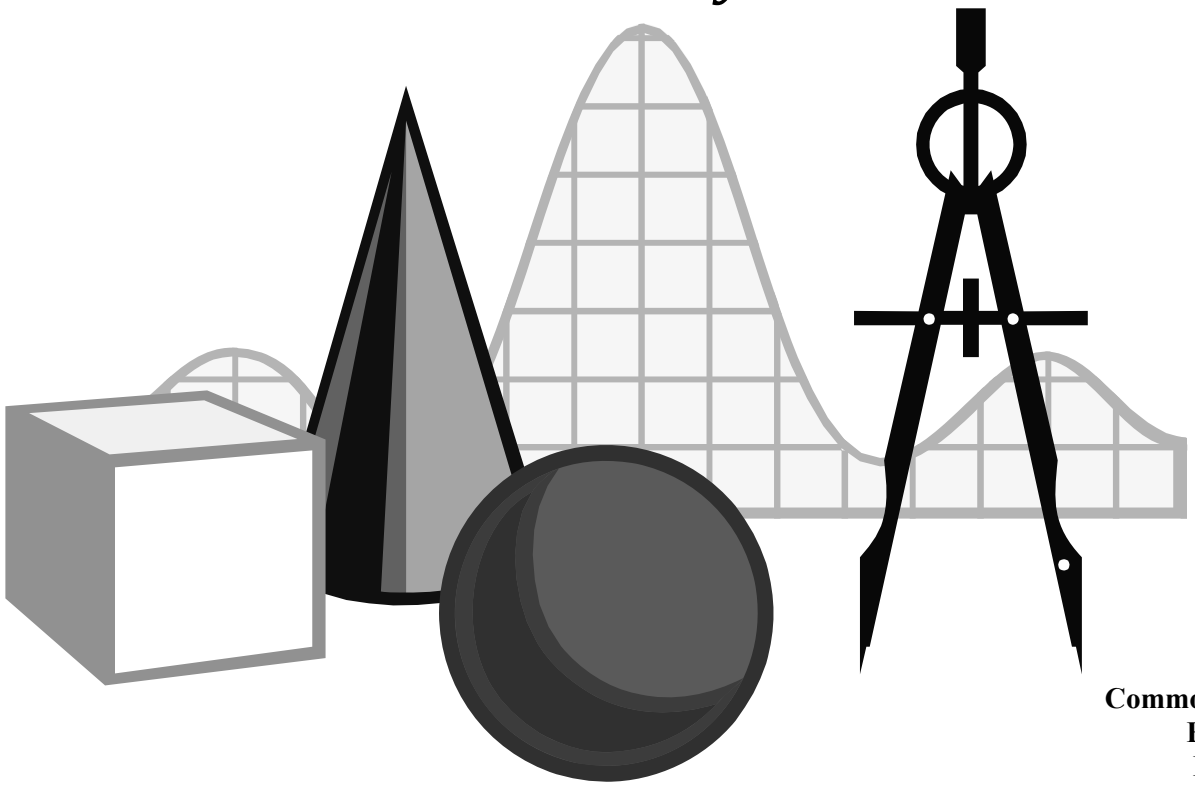
ALGEBRA I
STANDARD A.11

The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real-world problems, using mathematical models. Mathematical models will include linear and quadratic functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The graphing calculator can be used to determine the equation of a curve of best fit for a set of data. • The curve of best fit for the relationship among a set of data points can be used to make predictions where appropriate. • Many problems can be solved by using a mathematical model as an interpretation of a real-world situation. The solution must then refer to the original real-world situation. • Considerations such as sample size, randomness, and bias should affect experimental design.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Write an equation for ~~the line~~ a curve of best fit, given a set of ~~six to ten~~ no more than twenty data points in a table, ~~on~~ a graph, or ~~from~~ a ~~practical~~ real-world situation. • Make predictions about unknown outcomes, using the equation of the curve of best fit. • Design experiments and collect data to address specific, real-world questions. • Evaluate the ~~contextual validity~~reasonableness of a mathematical model of a real-world situation.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Geometry



Commonwealth of Virginia
Board of Education
Richmond, Virginia
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NOTICE TO THE READER

The Virginia Department of Education does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities.

The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into two columns: Essential Understandings and Essential Knowledge and Skills~~ and Essential Understandings~~. The purpose of each column is explained below.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

TOPIC: REASONING, LINES, AND TRANSFORMATIONS

GEOMETRY
STANDARD G.1

The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include

a) identifying the converse, inverse, and contrapositive of a conditional statement;
b) translating a short verbal argument into symbolic form;
c) using Venn diagrams to represent set relationships; and
d) using deductive reasoning.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Reasoning~~ Inductive reasoning, deductive reasoning, and proof are critical in establishing general claims. • Deductive reasoning is the method that uses logic to draw conclusions based on definitions, postulates, and theorems. • Inductive reasoning is the method of drawing conclusions from a limited set of observations. • Proof is a justification that is logically valid and based on initial assumptions, definitions, postulates, and theorems. • Logical arguments consist of a set of premises or hypotheses and a conclusion. • Euclidean geometry is an axiomatic system based on undefined terms (point, line and plane), postulates, and theorems. • When a conditional and its converse are true, the statements can be written as a biconditional, i.e., *iff* or *if and only if*. • Logical arguments that are valid may not be true. Truth and	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the converse, inverse, and contrapositive of a conditional statement. • Translate ~~short~~ verbal arguments into symbolic form, such as $(p \rightarrow q)$ and $(\sim p \rightarrow \sim q)$. • Determine the validity of a logical argument. • Use valid forms of deductive reasoning, including the law of syllogism, the law of the contrapositive, the law of detachment, and counterexamples. • Select and use various types of reasoning and methods of proof, as appropriate. • ~~Use and interpret Venn diagrams.~~ • Use Venn diagrams to represent set relationships, such as intersection~~,~~ and union.

TOPIC: REASONING, LINES, AND TRANSFORMATIONS

GEOMETRY
STANDARD G.1

The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include

a) identifying the converse, inverse, and contrapositive of a conditional statement;
b) translating a short verbal argument into symbolic form;
c) using Venn diagrams to represent set relationships; and
d) using deductive reasoning.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
validity are not synonymous.	• Interpret Venn diagrams. • Recognize and use the symbols of formal logic, which include $\rightarrow$, $\leftrightarrow$, $\sim$, $\therefore$, $\wedge$, and $\vee$.

TOPIC: REASONING, LINES, AND TRANSFORMATIONS

GEOMETRY
STANDARD G.2

The student will use the relationships between angles formed by two lines cut by a transversal to

a) determine whether two lines are parallel;
b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and
c) solve real-world problems involving angles formed when parallel lines are cut by a transversal.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Parallel lines ~~cut~~ intersected by a transversal form angles with specific relationships. • ~~A proof is a chain of logical statements starting with given information and leading to a conclusion.~~ • Some angle relationships may be used ~~to prove~~ when proving ~~that~~ two lines ~~cut~~ intersected by a transversal are parallel. • The Parallel Postulate differentiates Euclidean from non-Euclidean geometries such as spherical geometry and hyperbolic geometry.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Use properties, postulates, and theorems to determine whether two lines are parallel.~~ • Use algebraic~~,~~ and coordinate methods as well as deductive ~~methods~~ proofs to ~~determine~~ verify whether two lines are parallel. • Solve problems by using the relationships between pairs of angles formed by the intersection of two parallel lines and a transversal including corresponding angles, alternate interior angles, alternate exterior angles, and same-side (consecutive) interior angles. • Solve ~~practical~~ real-world problems involving intersecting and parallel lines in a plane.

TOPIC: REASONING, LINES, AND TRANSFORMATIONS

GEOMETRY
STANDARD G.3

The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include

a) investigating and using formulas for finding distance, midpoint, and slope;
b) applying slope to verify and determine whether lines are parallel or perpendicular;
c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and
d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Transformations and combinations of transformations can be used to describe movement of objects in a plane. • The distance formula is an application of the Pythagorean Theorem. • Geometric figures can be represented in the coordinate plane. • Techniques for investigating symmetry may include paper folding, coordinate methods, and dynamic geometry software. • Parallel lines have the same slope. • <u>The product of the slopes of perpendicular lines is -1.</u> • <u>The image of an object or function graph after an isomorphic transformation is congruent to the preimage of the object.</u>	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find the coordinates of the midpoint of a segment, using the midpoint formula. • <u>Compare the slopes to determine whether two lines are parallel, perpendicular, or neither.</u> • Determine whether a figure has point symmetry, line symmetry, <u>both,</u> or neither. • Given an image and preimage, identify the transformation that has taken place as a reflection, rotation, <u>dilation</u>, or translation. • Apply the distance formula to find the length of a line segment when given the coordinates of the endpoints.

TOPIC: REASONING, LINES, AND TRANSFORMATIONS

GEOMETRY
STANDARD G.4

The student will construct and justify the constructions of

a) a line segment congruent to a given line segment;
b) the perpendicular bisector of a line segment;
c) a perpendicular to a given line from a point not on the line;
d) a perpendicular to a given line at a given point on the line;
e) the bisector of a given angle;
f) an angle congruent to a given angle; and
g) a line parallel to a given line through a point not on the given line.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Construction techniques are used to solve ~~real-life~~ real-world problems in engineering, architectural design, and building construction. • Construction techniques may include using a straightedge and compass, paper folding, and dynamic geometry software.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Construct and justify the constructions of – a line segment congruent to a given line segment; – the perpendicular bisector of a line segment; – a perpendicular to a given line from a point not on the line; – a perpendicular to a given line at a point on the line; – the bisector of a given angle; – an angle congruent to a given angle; and – a line parallel to a given line through a point not on the given line.

TOPIC: TRIANGLES

GEOMETRY
STANDARD G.5

The student, given information concerning the lengths of sides and/or measures of angles in triangles, will

a) order the sides by length, given the angle measures;
b) order the angles by degree measure, given the side lengths;
c) determine whether a triangle exists; and
d) determine the range in which the length of the third side must lie.

These concepts will be considered in the context of real-world situations.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The longest side of a triangle is opposite the largest angle of the triangle and the shortest side is opposite the smallest angle. • In a triangle, ~~the measure of an angle and the lengths of the adjacent sides~~ the length of two sides and the included angle determine the length of the side opposite the angle. • In order for a triangle to exist, the length of each side must be within a range that is determined by the lengths of the other two sides.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Arrange the sides of a triangle in order from smallest to largest when given the measures of the angles.~~ Order the sides of a triangle by their lengths when given the measures of the angles. • ~~Arrange the angles of a triangle in order from smallest to largest when given the lengths of the sides.~~ Order the angles of a triangle by their measures when given the lengths of the sides. • Given the lengths of three segments, determine whether a triangle could be formed. • Given the lengths of two sides of a triangle, determine the range in which the length of the third side must lie. • Solve real-world problems given information about the lengths of sides and/or measures of angles in triangles.

TOPIC: TRIANGLES

GEOMETRY
STANDARD G.6

The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Congruence has real-life applications in a variety of areas, including art, architecture, and the sciences. • Congruence does not depend on the position of the triangle. • Concepts of logic can demonstrate congruence or similarity. • Congruent figures are also similar, but similar figures are not necessarily congruent.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use definitions, postulates, and theorems to ~~determine~~ <u>prove</u> ~~whether~~ triangles ~~are~~ congruent. • Use coordinate methods, such as the distance formula and the slope formula, to prove two triangles are congruent. • <u>Use algebraic methods to prove two triangles are congruent</u>.

TOPIC: TRIANGLES

GEOMETRY
STANDARD G.7

The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Similarity has real-~~life~~ world applications in a variety of areas, including art, architecture, and the sciences. • Similarity does not depend on the position of the triangle. • Congruent figures are also similar, but similar figures are not necessarily congruent.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use definitions, postulates, and theorems to ~~determine~~ prove ~~whether~~ triangles ~~are~~ similar. • Use algebraic methods, such as properties of proportions, to prove that triangles are similar. • Use coordinate methods, such as the distance formula, to prove two triangles are similar.

TOPIC: TRIANGLES

GEOMETRY
STANDARD G.8

The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The Pythagorean Theorem is essential for solving problems involving right triangles. • Many historical and algebraic proofs of the Pythagorean Theorem exist. • The relationships between the sides and angles of right triangles are useful in many applied fields. • Some practical problems can be solved by choosing an efficient representation of the problem. • Another formula for the area of a triangle is $A = \frac{1}{2}ab\sin C$. • The ratios of side lengths in similar right triangles (adjacent/hypotenuse or opposite/hypotenuse) are independent of the scale factor and depend only on the angle the hypotenuse makes with the adjacent side, thus justifying the definition and calculation of trigonometric functions using the ratios of side lengths for similar right triangles.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine whether a triangle formed with three given lengths is a right triangle. • Solve for missing lengths in geometric figures, using properties of 45°-45°-90° triangles. • Solve for missing lengths in geometric figures, using properties of 30°-60°-90° triangles. • Solve problems involving right triangles, using sine, cosine, and tangent ratios. • Solve real-world problems, using right triangle trigonometry and properties of right triangles.

TOPIC: POLYGONS AND CIRCLES

GEOMETRY
STANDARD G.9

The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The terms characteristics and properties can be used interchangeably to describe quadrilaterals. The term characteristics is used in elementary and middle school mathematics. • Quadrilaterals have a hierarchical nature based on the relationships between their sides, angles, and diagonals. • ~~Properties~~ Characteristics of quadrilaterals can be used to identify the quadrilateral and to find the measures of sides and angles.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Solve ~~practical~~ problems, including real-world problems, using the properties specific to parallelograms, rectangles, rhombi, squares, isosceles trapezoids, and trapezoids. • Prove that quadrilaterals have specific properties, using coordinate and algebraic methods, such as the distance formula, slope, and midpoint formula. • Prove the ~~properties~~ characteristics of quadrilaterals, using deductive reasoning, algebraic, and coordinate methods.

TOPIC: POLYGONS AND CIRCLES

GEOMETRY
STANDARD G.10

The student will solve real-world problems involving angles of polygons.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A regular polygon will tessellate the plane if the measure of an interior angle is a factor of 360. • Both regular and nonregular polygons can tessellate the plane. • Two intersecting lines form angles with specific relationships. • An exterior angle is formed by extending a side of a polygon. • The exterior angle and the corresponding interior angle form a linear pair. • The sum of the measures of the interior angles of a convex polygon may be found by dividing the interior of the polygon into nonoverlapping triangles.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Solve <u>real-world</u> problems involving the measures of interior and exterior angles of polygons. • Identify tessellations in art, construction, and nature. • Find the sum of the measures of the interior and exterior angles of a convex polygon. • Find the measure of each interior and exterior angle of a regular polygon. • <u>Find the number of sides of a regular polygon, given the measures of interior or exterior angles of the polygon.</u>

TOPIC: POLYGONS AND CIRCLES

GEOMETRY
STANDARD G.11

The student will use angles, arcs, chords, tangents, and secants to

a) investigate, verify, and apply properties of circles;
b) solve real-world problems involving properties of circles; and
c) find arc lengths and areas of sectors in circles.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Many relationships exist between and among angles, arcs, secants, chords, and tangents of a circle. • All circles are similar. • A chord is part of a secant. • Real-world applications may be drawn from architecture, art, and construction.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find lengths, angle measures, and arc measures associated with – two intersecting chords; – two intersecting secants; – an intersecting secant and tangent; – two intersecting tangents; and – central and inscribed angles. • Calculate the area of a sector and the length of an arc of a circle, using proportions. • Solve real-world problems associated with circles, using properties of angles, lines, and arcs. • ~~Prove~~Verify properties of circles, using deductive reasoning, algebraic, and coordinate methods.

TOPIC: POLYGONS AND CIRCLES

GEOMETRY
STANDARD G.12

The student, given the coordinates of the center of a circle and a point on the circle, will write the equation of the circle.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A circle is a locus of points equidistant from a given point, the center. • Standard form for the equation of a circle is $(x-h)^2+(y-k)^2=r^2$, ~~$(x-h)^2+(y-k)^2=r^2$~~ where the coordinates of the center of the circle are (h,k) and r is the length of the radius. • ~~The coordinates of the center of the circle are (h, k) and r is the length of the radius.~~ • The circle is a conic section.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the center, radius, and diameter of a circle from a given standard equation. • Use the distance formula to find the radius of a circle. • Given the coordinates of the center and radius of the circle, identify a point on the circle. • Given the equation of a circle in standard form, identify the coordinates of the center and find the radius of the circle. • Given the coordinates of the endpoints of a diameter, find the equation of the circle. • Given the coordinates of the center and a point on the circle, find the equation of the circle.

TOPIC: THREE-DIMENSIONAL FIGURES

GEOMETRY
STANDARD G.13

The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The surface area of a three-dimensional object is the sum of the areas of all its faces. • The volume of a three-dimensional object is the number of unit cubes that would fill the object.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find the total surface area of cylinders, prisms, pyramids, cones, and spheres, using the appropriate formulas. • Calculate the volume of cylinders, prisms, pyramids, cones, and spheres, using the appropriate formulas. • Solve ~~practical~~ problems, <u>including real-world problems,</u> involving total surface area and volume of cylinders, prisms, pyramids, cones, and spheres as well as combinations of three-dimensional figures. • <u>Calculators may be used to find decimal approximations for results.</u>

TOPIC: THREE-DIMENSIONAL FIGURES

GEOMETRY
STANDARD G.14

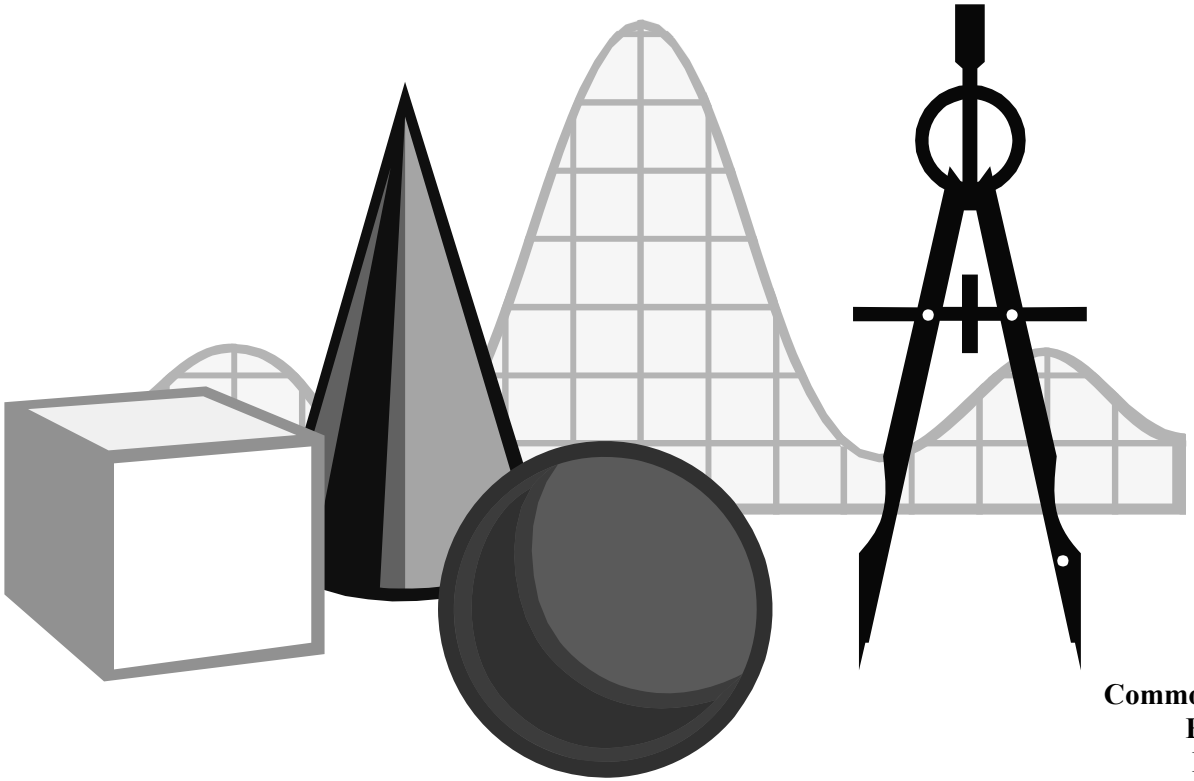
The student will use similar geometric objects in two- or three-dimensions to

a) compare ratios between side lengths, perimeters, areas, and volumes;
b) determine how changes in one or more dimensions of an object affect area and/or volume of the object;
c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and
d) solve real-world problems about similar geometric objects.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A change in one dimension of an object results in predictable changes in area and/or volume. • A constant ratio exists between corresponding lengths of sides of similar figures. • Proportional reasoning is integral to comparing attribute measures in similar objects.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Compare perimeters and areas of similar two-dimensional figures, using proportions.~~ • Describe how ~~a~~ changes in one or more ~~measures~~ dimensions affect~~s~~ other derived measures (perimeter, area, total surface area, and volume) of an object. • Describe how changes in one or more measures (perimeter, area, total surface area, and volume) affect other measures of an object. • Solve ~~practical~~ real-world problems involving measured attributes of similar objects.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Algebra, Functions, and Data Analysis



Commonwealth of Virginia
Board of Education
Richmond, Virginia
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Acknowledgements
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Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into two columns: Essential Understandings and Essential Knowledge and Skills~~ and Essential Understandings~~. The purpose of each column is explained below.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning. In Grades 6-8, these essential understandings are presented as questions to facilitate teacher planning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

TOPIC: ALGEBRA AND FUNCTIONS

ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.1

The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include:

a) continuity;
b) local and absolute maxima and minima;
c) domain and range;
d) zeros;
e) intercepts;
f) intervals in which the function is increasing/decreasing;
g) end behaviors; and
h) asymptotes.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The domain of a function consists of the first coordinates of the ordered pairs that are elements of a function. Each element in the domain is an input into the independent variable of the function. • The range of a function consists of the second coordinates of the ordered pairs that are elements of a function. Each element in the range is an output in the dependent variable of a function. • For each x in the domain of f, x is a member of the input of the function f, $f(x)$ is a member of the output of f, and the ordered pair $[x, f(x)]$ is a member of f. • A value x in the domain of f is an x-intercept or a zero of a function f if and only if $f(x) = 0$. • Functions describe the relationship between two variables where each input is paired to a unique output.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the domain and range for a relation, given a set of ordered pairs, a table, or a graph. • For each x in the domain of f, find $f(x)$. • Identify the zeros of the function algebraically and confirm them, using the graphing calculator. • Identify the domain, range, zeros, and intercepts of a function presented algebraically or graphically. • Recognize restricted/discontinuous domains and ranges. • Recognize graphs of parent functions for linear, quadratic, exponential and logarithmic functions.

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f) intervals in which the function is increasing/decreasing;
g) end behaviors; and
h) asymptotes.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Functions are used to model real-world phenomena. • A function is increasing on an interval if its graph, as read from left to right, is rising in that interval. • A function is decreasing on an interval if its graph, as read from left to right, is going down in that interval. • Exponential and logarithmic functions are either strictly increasing or strictly decreasing. • A function is continuous on an interval if the function is defined for every value in the interval and there are no breaks in the graph. A continuous function can be drawn without lifting the pencil. • A turning point is a point on a continuous interval where the graph changes from increasing to decreasing or from decreasing to increasing.	• Identify *x*-intercepts (zeros), *y*-intercepts, symmetry, asymptotes, intervals for which the function is increasing or decreasing, points of discontinuity, end behavior, and maximum and minimum points, given a graph of a function. • Describe continuity of a function on its domain or at a point. • Express intervals using correct interval notation and/or a compound inequality.

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d) zeros;
e) intercepts;
f) intervals in which the function is increasing/decreasing;
g) end behaviors; and
h) asymptotes.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A function, f, has a local maximum in some interval at $x = a$ if $f(a)$ is the largest value of f in that interval. • A function, f, has a local minimum in some interval at $x = a$ if $f(a)$ is the smallest value of f in that interval. • Asymptotes can be used to describe local behavior and end behavior of graphs. They are lines or other curves that approximate the graphical behavior of a function. • The following statements are equivalent: – k is a zero of the polynomial function f; – k is a solution of the polynomial equation $f(x) = 0$; – k is an x-intercept for the graph of the polynomial; and – $(x - k)$ is a factor of the polynomial. • Continuous and discontinuous functions can be identified by their equations or graphs. The end behavior of a function refers to the	

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ALGEBRA, FUNCTIONS AND DATA ANALYSIS
STANDARD AFDA.1

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g) end behaviors; and
h) asymptotes.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
graphical behavior of a function as x goes to positive and negative infinity.	

TOPIC: ALGEBRA AND FUNCTIONS

ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.2

The student will use knowledge of transformations to write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic).

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Knowledge of transformational graphing using parent functions can be used to generate a mathematical model from a scatter plot that approximates the data. • Transformations include: - Translations (horizontal and vertical shifting of a graph) - Reflections - Dilations (stretching and compressing graphs) and - Rotations • The equation of a line can be determined by two points on the line or by the slope and a point on the line.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Write an equation of a line when given the graph of a line. • Recognize graphs of parent functions for linear, quadratic, exponential and logarithmic functions. • Write the equation of a linear, quadratic, exponential, or logarithmic function in *(h, k)* form given the graph of the parent function and transformation information. • Describe the transformation from the parent function given the equation written in *(h, k)* form or the graph of the function. • Given the equation of a function, recognize the parent function and transformation to graph the given function. • Recognize the vertex of a parabola given a quadratic equation in *(h, k)* form or graphed. • Describe the parent function represented by a scatter plot.

TOPIC: ALGEBRA AND FUNCTIONS

ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.3

The student will collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students will use the best fit equation to interpolate function values, make decisions, and justify conclusions with algebraic and/or graphical models.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The regression equation modeling a set of data points can be used to make predictions where appropriate. • Data and scatter plots may indicate patterns that can be modeled with a function. • Graphing calculators can be used to collect, organize, picture, and create an algebraic model of the data. • Data that fit linear, quadratic, exponential, and logarithmic models arise from practical situations. • Two variables may be strongly associated without a cause-and-effect relationship existing between them. • Each data point may be considered to be comprised of two parts: fit (the part explained by the model) and residual (the result of chance variation or of variables not measured). • Residual = Actual – Fitted • Least squares regression generates the equation of the line that minimizes the sum of the squared distances between the data points and the line.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Write an equation for the line of best fit, given a set of data points in a table, on a graph, or from a practical situation. • Make predictions about unknown outcomes, using the equation of a line of best fit. • Collect and analyze data to make decisions and justify conclusions. • Investigate scatter plots to determine if patterns exist, and identify the patterns. • Find an equation for the curve of best fit for data, using a graphing calculator. Models will include linear, quadratic, exponential, and logarithmic functions. • Make predictions, using data, scatter plots, or equation of curve of best fit. • Given a set of data, determine the model that would best describe the data. • Describe the errors inherent in extrapolation beyond the range of

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ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A correlation coefficient measures the degree of association between two variables that are related linearly.	the data. • Estimate the correlation coefficient when given data and/or scatter plots.

TOPIC: ALGEBRA AND FUNCTIONS

ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.4

The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The most appropriate representation of a function depends on the questions to be answered and/or the analysis to be done. • Given data may be represented as discrete points or as a continuous graph with respect to the real-world context. • Real-world data may best be represented as a table, a graph, or as a formula.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Given an equation, graph a linear, quadratic, exponential or logarithmic function with the aid of a graphing calculator. • Make predictions given a table of values, a graph, or an algebraic formula. • Describe relationships between data represented in a table, in a scatter plot, and as elements of a function. • Determine the appropriate representation of data derived from real-world situations. • Analyze and interpret the data in context of the real-world situation.

TOPIC: ALGEBRA AND FUNCTIONS

ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.5

The student will determine optimal values in problem situations by identifying constraints and using linear programming techniques.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Linear programming models an optimization process. • A linear programming model consists of a system of constraints and an objective quantity that can be maximized or minimized. • Any maximum or minimum value will occur at a corner point of a feasible region.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Model practical problems with systems of linear inequalities. • Solve systems of linear inequalities with pencil and paper and using a graphing calculator. • Solve systems of equations algebraically and graphically. • Identify the feasibility region of a system of linear inequalities. • Identify the coordinates of the corner points of a feasibility region. • Find the maximum or minimum value for the function defined over the feasibility region. • Describe the meaning of the maximum or minimum value within its context.

TOPIC: DATA ANALYSIS

ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.6

The student will calculate probabilities. Key concepts include:

a) **conditional probability;**
b) **dependent and independent events;**
c) **addition and multiplication rules;**
d) **counting techniques (permutations and combinations); and**
e) **Law of Large Numbers.**

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The *Fundamental Counting Principle* states that if one decision can be made *n* ways and another can be made *m* ways, then the two decisions can be made *nm* ways. • *Permutations* are used to calculate the number of possible arrangements of objects. • *Combinations* are used to calculate the number of possible selections of objects without regard to the order selected. • A *sample space* is the set of all possible outcomes of a random experiment. • An *event* is a subset of the sample space. • *P(E)* is a way to represent the probability that the event E occurs. • *Mutually exclusive events* are events that cannot both occur simultaneously. • If *A* and *B* are mutually exclusive then $P(A \cup B) = P(A) + P(B)$.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and contrast permutations and combinations. • Calculate the number of permutations of *n* objects taken *r* at a time. • Calculate the number of combinations of *n* objects taken *r* at a time. • Define and give contextual examples of complementary, dependent, independent, and mutually exclusive events. • Given two or more events in a problem setting, determine if the events are complementary, dependent, independent, and/or mutually exclusive. • Find conditional probabilities for dependent, independent, and mutually exclusive events. • Represent and calculate probabilities using Venn diagrams and probability trees.

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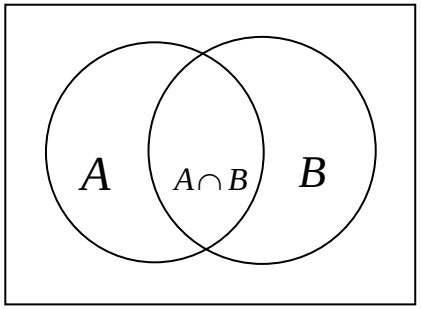
ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.6

The student will calculate probabilities. Key concepts include:

a) conditional probability;
b) dependent and independent events;
c) addition and multiplication rules;
d) counting techniques (permutations and combinations); and
e) Law of Large Numbers.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The complement of event A consists of all outcomes in which event A does not occur. • *P(B|A)* is the probability that *B* will occur given that *A* has already occurred. *P(B|A)* is called *the conditional probability* of *B* given *A*. • Venn diagrams may be used to examine conditional probabilities.  $P(B\|A) = \frac{P(A \cap B)}{P(A)}$ $\Rightarrow P(A \cap B) = P(A)P(B\|A)$ • Two events, *A* and *B*, are independent if the occurrence of one does not affect the probability of the occurrence of the other. If *A* and *B* are not independent, then they are said to be dependent.	• Analyze, interpret and make predictions based on theoretical probability within real-world context. • Given a real-world situation, determine when to use permutations or combinations.

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d) counting techniques (permutations and combinations); and
e) Law of Large Numbers.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• If A and B are independent events, then $P(A \cap B) = P(A)P(B)$. • The Law of Large Numbers states that as a procedure is repeated again and again, the relative frequency probability of an event tends to approach the actual probability.	

TOPIC: DATA ANALYSIS

ALGEBRA, FUNCTIONS AND DATA ANALYSIS STANDARD AFDA.7

The student will analyze the normal distribution. Key concepts include:

a) characteristics of normally distributed data;
b) percentiles;
c) normalizing data using z-scores; and
d) area under the standard normal curve and probability.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Analysis of the descriptive statistical information generated by a univariate data set includes the relationships between central tendency, dispersion, and position. • The normal distribution curve is a family of symmetrical curves defined by the mean and the standard deviation. • Areas under the curve represent probabilities associated with continuous distributions. • The normal curve is a probability distribution and the total area under the curve is 1. • The mean of the data in a standard normal density function is 0 and the standard deviation is 1. This allows for the comparison of unlike data. • The amount of data that falls within 1, 2, or 3 standard deviations of the mean is constant and the basis of z-score data normalization.	• Interpret mean, median, mode, range, interquartile range, variance, and standard deviation of a univariate data set in terms of the problem's context. • Explain the influence of outliers on a univariate data set. • Explain ways in which standard deviation addresses dispersion by examining the formula for standard deviation. • Identify the properties of a normal probability distribution. • Describe how the standard deviation and the mean affect the graph of the normal distribution. • Determine the probability of a given event, using the normal distribution.

TOPIC: DATA ANALYSIS

ALGEBRA, FUNCTIONS AND DATA ANALYSIS
STANDARD AFDA.8

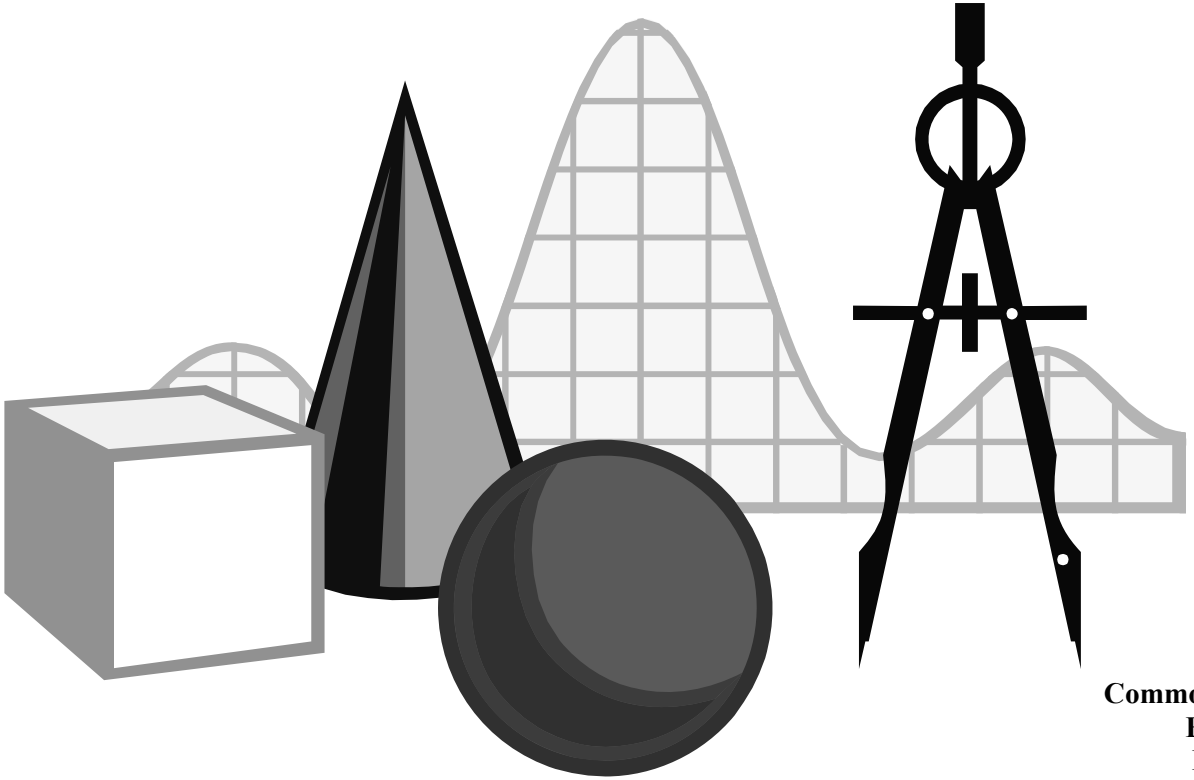
The student will design and conduct an experiment/survey. Key concepts include:

a) **sample size;**
b) **sampling technique;**
c) **controlling sources of bias and experimental error;**
d) **data collection; and**
e) **data analysis and reporting.**

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The value of a sample statistic may vary from sample to sample, even if the simple random samples are taken repeatedly from the population of interest. • Poor data collection can lead to misleading and meaningless conclusions. • The purpose of sampling is to provide sufficient information so that population characteristics may be inferred. • Inherent bias diminishes as sample size increases. • Experiments must be carefully designed in order to detect a cause-and-effect relationship between variables. • Principles of experimental design include comparison with a control group, randomization, and blindness.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and contrast controlled experiments and observational studies and the conclusions one may draw from each. • Identify biased sampling methods. • Select a data collection method appropriate for a given context. • Investigate and describe sampling techniques, such as simple random sampling, stratified sampling, and cluster sampling. • Determine which sampling technique is best, given a particular context. • Plan and conduct an experiment or survey. The experimental design should address control, randomization, and minimization of experimental error. • Design a survey instrument.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Computer Mathematics



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TOPIC: PROBLEM SOLVING

COMPUTER MATHEMATICS
STANDARD COM.1

The student will apply programming techniques and skills to solve practical real-world problems in mathematics arising from consumer, business, and other applications in mathematics. Problems will include opportunities for students to analyze data in charts, graphs, and tables and to use their knowledge of equations, formulas, and functions to solve these problems.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The computer is an essential tool for mathematical problem solving in consumer-related problems. • A subtask that has been solved previously may be used again and again. • Programming languages require the use of particular structures to express algorithms as programs. • Designing algorithms is the problem solving phase of computer programming. • Real-world problems that can be modeled mathematically can be solved with a computer program. • Data arising from probability and statistics applications can be displayed in tables and graphs and analyzed within the structure of a computer program.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Design and implement computer programs to solve consumer problems. • Analyze and interpret graphs, charts, and tables in the design and implementation of a computer program. • Design and implement computer programs to – solve mathematical problems, using formulas; – solve mathematical problems, using equations; – solve mathematical problems, using functions; – solve problems related to geometry, business, and leisure; – solve probability problems; – solve data-analysis problems; and – solve statistical problems.

TOPIC: PROGRAM DESIGN

COMPUTER MATHEMATICS
STANDARD COM.2

The student will design, write, test, debug, and document a program. Programming documentation will include preconditions and postconditions of program segments, input/output specifications, the step-by-step plan, the test data, a sample run, and the program listing with appropriately placed comments.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The successful completion of a structured program requires problem solving skills.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe what a computer program is. • List and describe the stages involved in writing a computer program. • Describe the function of an algorithm. • Describe the interplay between hardware and software in program execution. • Compare and contrast compiling and executing a program. • Determine what a given output statement will print. • Debug a program. • Provide required documentation for a program.

TOPIC: PROGRAM DESIGN

COMPUTER MATHEMATICS
STANDARD COM.3

The student will write program specifications that define the constraints of a given problem. These specifications will include descriptions of preconditions, postconditions, the desired output, analysis of the available input, and an indication as to whether or not the problem is solvable under the given conditions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A programmer begins the programming process by analyzing the problem and developing a general solution (algorithm). • The successful completion of a structured program requires problem solving skills.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • For a given problem, describe the preconditions, postconditions, and desired output. • Determine whether or not a problem is solvable. • Write program specifications that define the constraints of a problem.

TOPIC: PROGRAM DESIGN

COMPUTER MATHEMATICS
STANDARD COM.4

The student will design a step-by-step plan (algorithm) to solve a given problem. The plan will be in the form of a program flowchart, pseudo code, hierarchy chart, and/or data-flow diagram.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• All programs are implementations of algorithms.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Design a step-by-step plan to solve a problem. • Utilize the following problem solving formats: – flowchart; – pseudo code; – hierarchy chart; and – data-flow diagram.

TOPIC: PROGRAM DESIGN

COMPUTER MATHEMATICS
STANDARD COM.5

The student will divide a given problem into manageable sections (modules) by task and implement the solution. The modules will include an appropriate user-defined function, subroutines, and procedures. Enrichment topics might include user-defined libraries (units) and object-oriented programming.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Functional decomposition is a way to develop a program in which the problem is divided into subproblems whose solutions comprise the solution to the original problem.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Subdivide a problem into modules by task. • Implement the solution of the problem. • Write task-oriented modules, including – a user-defined function; – subroutines; and – procedures. • Determine the need for a subroutine or user-defined function. • Determine the difference between and the need for internal and external subroutines and functions.

TOPIC: PROGRAM DESIGN

COMPUTER MATHEMATICS
STANDARD COM.12

The student will translate a mathematical expression into a computer statement, which involves writing assignment statements and using the order of operations.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A variable identifies a location in memory where a data value that can be changed is stored. • An assignment statement stores the value of an expression into a variable. • The order of operations is – parentheses; – exponents; – multiplication and division in order from left to right; and – addition and subtraction in order from left to right. • Variable assignment statements will differ depending upon the programming language used.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Translate a mathematical expression into a computer statement. • Use the order of operations to simplify expressions. • Write variable assignment statements. • Construct and evaluate expressions that include multiple arithmetic operations.

TOPIC: PROGRAM DESIGN

COMPUTER MATHEMATICS
STANDARD COM.13

The student will select and implement built-in (library) functions in processing data.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The argument of a library function is a value or expression associated with the independent variable. • A library function is a subroutine.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use library functions in designing programs to process data. • Use library functions that are arithmetic or string operators. • Invoke a value-returning function.

TOPIC: PROGRAM DESIGN

COMPUTER MATHEMATICS
STANDARD COM.14

The student will implement conditional statements that include "if/then" statements, "if/then/else" statements, case statements, and Boolean logic.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Boolean logic is a system using variables with only two values: TRUE and FALSE. • The "if" statement is the fundamental control structure that allows branches in the flow of control.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Construct a simple logical (Boolean) expression to evaluate a given condition. • Construct an "if/then" statement to perform a specific task. • Construct an "if/then/else" statement to perform a specific task. • Use conditional statements to incorporate decision making into programs.

TOPIC: PROGRAM DESIGN

COMPUTER MATHEMATICS
STANDARD COM.17

The student will implement pre-existing algorithms, including sort routines, search routines, and simple animation routines.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Arranging values into an order is known as sorting. • A sequential search algorithm starts at the beginning of a list and examines each data value in sequence. • Implementation of animation routines will differ depending upon the programming language used.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Implement pre-existing algorithms into a program. • Implement a sort routine on a one-dimensional array. • Implement a sequential search routine on a one-dimensional array. • Implement a binary search routine on a one-dimensional array. • Implement a simple animation routine.

TOPIC: PROGRAM IMPLEMENTATION

COMPUTER MATHEMATICS
STANDARD COM.6

The student will design and implement the input phase of a program, which will include designing screen layout and getting information into the program by way of user interaction, data statements, and/or file input. The input phase will also include methods of filtering out invalid data (error trapping).

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A program needs data on which to operate. • A file is a named area in secondary storage that holds a collection of information.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Design a screen layout to facilitate input. • Design program information input by – user interaction; – data statements (BASIC); and – file input. • Filter out invalid data, using a variety of methods (error trapping). • Construct input statements to read values into a program. • Determine the contents of variables that have been assigned values by input statements.

TOPIC: PROGRAM IMPLEMENTATION

COMPUTER MATHEMATICS
STANDARD COM.7

The student will design and implement the output phase of a computer program, which will include designing output layout, accessing a variety of output devices, using output statements, and labeling results.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Output is dependent on input. • Implementation of the output portion of a program includes designing the output and displaying it in the desired format.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Design an output layout. • Access various output devices. • Use output statements. • Label results.

TOPIC: PROGRAM IMPLEMENTATION

COMPUTER MATHEMATICS
STANDARD COM.8

The student will design and implement computer graphics, which will include topics appropriate for the available programming environment as well as student background. Students will use graphics as an end in itself, as an enhancement to other output, and as a vehicle for reinforcing programming techniques.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Work with computer graphics is specific to the computer operating system.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Design computer graphics. • Implement computer graphics. • Plot points and areas. • Determine and set window or screen dimensions. • Determine and set screen and background colors. • Use box commands. • Describe the role of graphics in the computer environment.

TOPIC: PROGRAM IMPLEMENTATION

COMPUTER MATHEMATICS
STANDARD COM.15

The student will implement loops, including iterative loops. Other topics will include single entry point, single exit point, preconditions, and postconditions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A loop executes a sequence of statements repeatedly. • Nested loops contain other loops.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine when a loop is needed in a program. • Implement loops into programs. Include – iterative loops; – pretest loops; and – posttest loops. • Incorporate single entry point, single exit point, pre-conditions, and post-conditions into loops.

TOPIC: PROGRAM IMPLEMENTATION

COMPUTER MATHEMATICS
STANDARD COM.16

The student will select and implement appropriate data structures, including arrays (one-dimensional and/or multidimensional), files, and records. Implementation will include creating the data structure, putting information into the structure, and retrieving information from the structure.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Structured data types are collections of components that are given a single name and whose organization is characterized by the method used to access the individual components. • Multidimensional arrays may be viewed as arrays of one-dimensional arrays.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Declare a one-dimensional or two-dimensional array for a given problem. • Choose an appropriate component type for an array. • Assign a value to an array component. • Fill an array with data, and process the data in the array. • Access a particular component of a two-dimensional array. • Process a two-dimensional array by rows and by columns. • Retrieve data from an array.

TOPIC: DATA MANIPULATION

COMPUTER MATHEMATICS
STANDARD COM.9

The student will define simple variable data types that include integer, real (fixed and scientific notation), character, string, and Boolean.

STANDARD COM.10

The student will use appropriate variable data types, including integer, real (fixed and scientific notation), character, string, and Boolean. This will also include variables representing structured data types.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A data type is a set of values and a set of operations on the values. • Boolean data has only two literal constants, and they represent TRUE and FALSE. • A string is an array for which there exists an aggregate constant.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Define and use variable data types, including – integer; – real (fixed and scientific notation); – character; – string; and – Boolean. • Write numeric and string variables, using valid names.

TOPIC: DATA MANIPULATION

COMPUTER MATHEMATICS
STANDARD COM.11

The student will describe the way the computer stores, accesses, and processes variables, including the following topics: the use of variables versus constants, variables' addresses, pointers, parameter passing, scope of variables, and local versus global variables.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Computers consist of hardware components that interact with software.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine when use of a variable is appropriate. • Describe how a computer stores, accesses, and processes variables. • Incorporate variable addresses, pointers, and parameter passing into programs. • Differentiate between local and global variables, and describe their appropriate use. • Compare and contrast variables and constants.

TOPIC: PROGRAM TESTING

COMPUTER MATHEMATICS
STANDARD COM.18

The student will test a program, using an appropriate set of data. The set of test data should be appropriate and complete for the type of program being tested.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A program test can reveal problems (bugs) in the program. • Testing a program for bugs is part of problem solving. • Various forms of data can be used to debug a program.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Test a program, using an appropriate and complete set of data.

TOPIC: PROGRAM TESTING

COMPUTER MATHEMATICS
STANDARD COM.19

The student will debug a program, using appropriate techniques (e.g., appropriately placed controlled breaks, the printing of intermediate results, and other debugging tools available in the programming environment), and identify the difference between syntax errors and logic errors.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Debugging a program is problem solving.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Debug a program, using controlled breaks, the printing of intermediate results, and other debugging tools. • Identify the differences among syntax errors, runtime errors, and logic errors.

TOPIC: PROGRAM TESTING

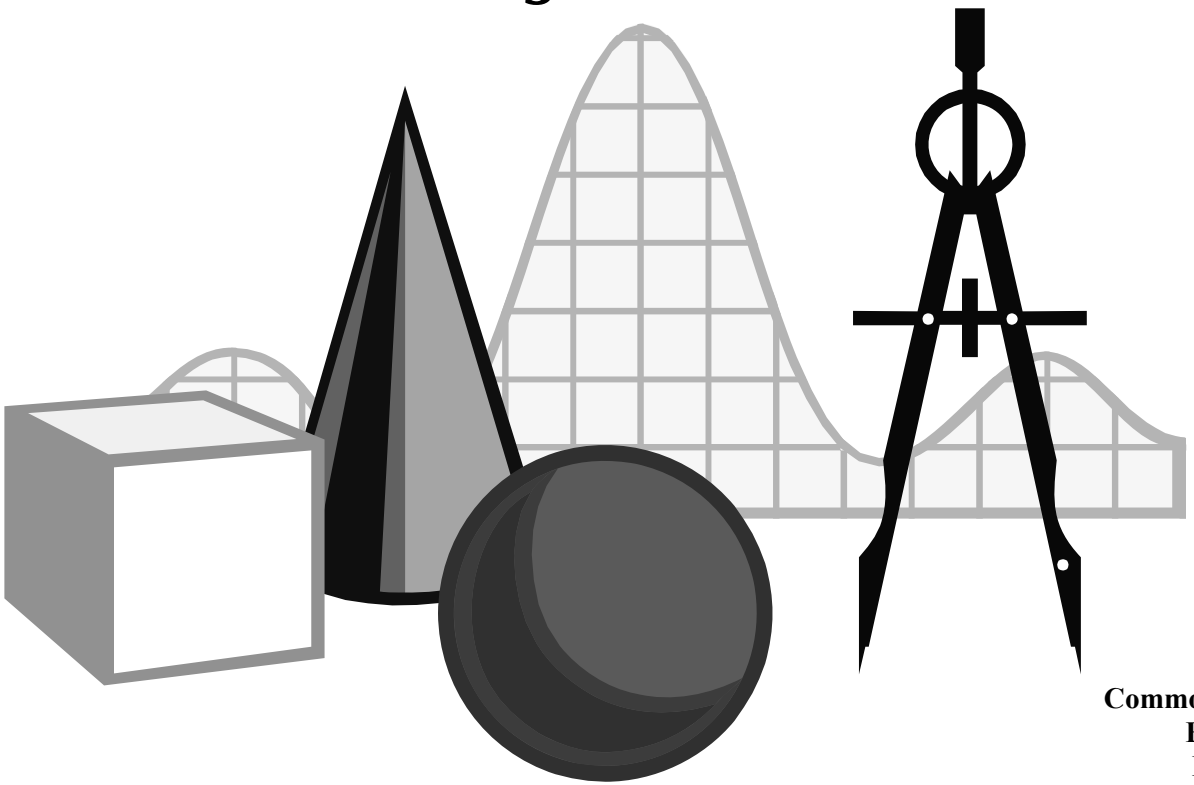
COMPUTER MATHEMATICS
STANDARD COM.20

The student will design, write, test, debug, and document a complete structured program that requires the synthesis of many of the concepts contained in previous standards.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The successful completion of a structured program requires problem solving skills.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Design, write, test, debug, and document a complete structured program.

MATHEMATICS STANDARDS OF LEARNING
PROPOSED CURRICULUM FRAMEWORK

Algebra II



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NOTICE TO THE READER

The Virginia Department of Education does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities.

The 2009 *Mathematics Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into two columns: Essential Understandings and Essential Knowledge and Skills~~ and Essential Understandings~~. The purpose of each column is explained below.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

TOPIC: EXPRESSIONS AND OPERATIONS

ALGEBRA II
STANDARD AII.1

The student, given rational, radical, or polynomial expressions, will

a) add, subtract, multiply, divide, and simplify rational algebraic expressions;
b) add, subtract, multiply, divide, and simplify radical expressions containing rational numbers and variables, and expressions containing rational exponents;
c) write radical expressions as expressions containing rational exponents and vice versa; and
d) factor polynomials completely.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Computational skills applicable to numerical fractions also apply to rational expressions involving variables. • Radical expressions can be written and simplified using rational exponents. • Only radicals with a common radicand and index can be added or subtracted. • A relationship exists among arithmetic complex fractions, algebraic complex fractions, and rational numbers. • The complete factorization of polynomials has occurred when each factor is a prime polynomial. • Pattern recognition can be used to determine complete factorization of a polynomial.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Add, subtract, multiply, and divide rational algebraic expressions ~~whose denominators are monomials or polynomial expressions in completely factored form~~. • Simplify a rational algebraic expression with common monomial or binomial factors. • Recognize a complex algebraic fraction, and simplify it as a quotient or product of simple algebraic fractions. • Simplify radical expressions containing positive rational numbers and variables. • Convert from radical notation to exponential notation, and vice versa. • Add and subtract radical expressions ~~with like radicands~~. • Multiply and divide radical expressions not requiring rationalizing

TOPIC: EXPRESSIONS AND OPERATIONS

ALGEBRA II
STANDARD AII.1

The student, given rational, radical, or polynomial expressions, will

a) add, subtract, multiply, divide, and simplify rational algebraic expressions;
b) add, subtract, multiply, divide, and simplify radical expressions containing rational numbers and variables, and expressions containing rational exponents;
c) write radical expressions as expressions containing rational exponents and vice versa; and
d) factor polynomials completely.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
	the denominators. • ~~Determine the greatest monomial factor as a first step in complete factorization.~~ • ~~Recognize squares and cubes of positive integers.~~ • ~~Recognize examples of general patterns:~~ Factor polynomials by applying general patterns including difference of squares, sum and difference of cubes, and perfect square trinomials. • ~~Factor polynomials by applying general patterns.~~ • Factor polynomials completely over the integers

TOPIC: ~~RELATIONS AND~~ FUNCTIONS

ALGEBRA II
STANDARD AII.2

The student will investigate and apply the properties of arithmetic and geometric sequences and series to solve real-world problems, including writing the first *n* terms, finding the nth term, and evaluating summation formulas. Notation will include $\sum$ and a_n.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Sequences and series arise from real-world situations. • The study of sequences and series is an application of the investigation of patterns. • A sequence is a function whose domain is the set of natural numbers. • Sequences can be defined explicitly and recursively.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Distinguish between a sequence and a series. • ~~Recognize patterns in a sequence.~~ • Generalize patterns in a sequence using explicit and recursive formulas. • Use and interpret the notations $\sum$, n, n^{th} term, and a_n. • ~~Write the first *n* terms in an arithmetic or geometric sequence.~~ • Given the formula, find a_n (the nth term) for an arithmetic or a geometric sequence. • Given formulas, find the sum, S_n, of the first n terms of an arithmetic or geometric series~~, including infinite series~~. • Given the formula, find the sum of a convergent infinite series. • ~~Use finite geometric series to m~~Model real-world situations using sequences and series.

TOPIC: EXPRESSIONS AND OPERATIONS

ALGEBRA II
STANDARD AII.3

The student will perform operations on complex numbers, express the results in simplest form using patterns of the powers of *i*, and identify field properties that are valid for the complex numbers.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Complex numbers are organized into a hierarchy of subsets ~~with properties applicable to each subset~~. • ~~Complex numbers are a superset of real numbers and, as a system, contain solutions for equations that are not solvable over the set of real numbers.~~ • A complex number multiplied by its conjugate is a real number. • Equations having no real number solutions may have solutions in the set of complex numbers. • Field properties apply to complex numbers as well as real numbers. • All complex numbers can be written in the form a+b*i* where *a* and *b* are real numbers and *i is* $\sqrt{-1}$. • ~~Complex numbers are a superset of real numbers.~~	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Identify examples of field properties: commutative, associative, identity, inverse, and distributive.~~ • ~~Identify examples of axioms of equality: reflexive, symmetric, transitive, substitution, addition, and multiplication.~~ • ~~Identify examples of axioms of inequality and order: trichotomy, transitive, addition, and multiplication.~~ • Recognize that the square root of –1 is represented as *i*. • ~~Define and identify a complex number.~~ • ~~Apply the definition of *i* to simplify square roots of negative numbers.~~ • Determine which field properties apply to the complex number system. • Simplify radical expressions containing negative rational numbers and express in a+b*i* form. • Simplify powers of *i*.

TOPIC: EXPRESSIONS AND OPERATIONS

ALGEBRA II
STANDARD AII.3

The student will perform operations on complex numbers, express the results in simplest form using patterns of the powers of *i*, and identify field properties that are valid for the complex numbers.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
	• Add, subtract, and multiply complex numbers. • Place the following sets of numbers in a hierarchy of subsets: complex, pure imaginary, real, rational, irrational, integers, whole, and natural. • Write a real number in a+b*i* form. • Write a pure imaginary number in a+b*i* form.

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA II
STANDARD AII.4

The student will solve, algebraically and graphically,

a) absolute value equations and inequalities;
b) quadratic equations over the set of complex numbers;
c) equations containing rational algebraic expressions; and
d) equations containing radical expressions.

Graphing calculators will be used for solving and for confirming the algebraic solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~A solution of an equation makes the equation true.~~ • A quadratic function whose graph does not intersect the *x*-axis has roots with imaginary components. • The quadratic formula can be used to solve any quadratic equation. • The value of the discriminant of a quadratic equation can be used to describe the ~~nature~~number of ~~the roots~~real and complex solutions. • ~~A quadratic equation whose graph does not intersect the *x*-axis has only complex solutions.~~ • ~~Complex solutions occur in pairs (conjugates).~~ • ~~Absolute value equations and inequalities can be used to model practical problems.~~ • The definition of absolute value (for any real numbers a and b, where b ≥ 0, if $\lvert a \rvert = b$, then a = b or ~~-a = b~~a = - b) is used in	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Solve absolute value equations and inequalities algebraically and graphically. • ~~Solve absolute value equations in one variable algebraically and graphically, using a graphing calculator.~~ • ~~Solve absolute value inequalities in one variable algebraically and graphically.~~ • ~~Express the solutions to absolute value equations and inequalities in one variable graphically and as an algebraic inequality.~~ • ~~Graph absolute value equations in two variables.~~ • ~~Verify solutions to absolute value equations and inequalities in two variables, using a graphing calculator.~~ • ~~Recognize a quadratic equation~~. • Solve a quadratic equation over the set of complex numbers using

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA II
STANDARD AII.4

The student will solve, algebraically and graphically,

a) absolute value equations and inequalities;
b) quadratic equations over the set of complex numbers;
c) equations containing rational algebraic expressions; and
d) equations containing radical expressions.

Graphing calculators will be used for solving and for confirming the algebraic solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
solving absolute value equations and inequalities. • Absolute value inequalities can be solved graphically or by using a compound statement. • Real-world problems can be interpreted, represented, and solved using equations and inequalities. • The process of solving radical or rational equations can lead to extraneous solutions. • Equations can be solved in a variety of ways. • ~~The solution of an equation in one variable can be found by graphing each side of the equation separately and finding the *x*-coordinate of the point of intersection~~. • ~~Practical problems can be interpreted, represented, and solved using equations.~~ • Set builder notation may be used to represent solution sets of equations and inequalities.	an appropriate strategy. • ~~Identify from a graph the real solutions to a quadratic equation.~~ • ~~Find the real roots of a quadratic equation, using a graphing calculator.~~ • Calculate the discriminant of a quadratic equation to determine the number of real and complex solutions. • Solve equations containing rational algebraic expressions with monomial or binomial denominators algebraically and graphically. • Solve an equation containing a radical expression algebraically and graphically. ~~The equation will contain a linear expression under the radical, and all terms outside the radical will be constants.~~ • Verify possible solutions to an equation containing rational or radical expressions. • Apply an appropriate equation to solve a real-world problem.

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA II
STANDARD AII.4

The student will solve, algebraically and graphically,

a) absolute value equations and inequalities;
b) quadratic equations over the set of complex numbers;
c) equations containing rational algebraic expressions; and
d) equations containing radical expressions.

Graphing calculators will be used for solving and for confirming the algebraic solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
	• ~~Identify from a graph the solutions to an equation containing rational or radical expressions.~~ • ~~Solve an equation containing rational or radical expressions, using a graphing calculator.~~ • ~~Check possible solutions to an equation containing rational or radical expressions, using a graphing calculator.~~

TOPIC: EQUATIONS AND INEQUALITIES

ALGEBRA II
STANDARD AII.5

The student will solve nonlinear systems of equations, including linear-quadratic and quadratic-quadratic, algebraically and graphically. Graphing calculators will be used as a tool to visualize graphs and predict the number of solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Solutions of a nonlinear system of equations are numerical values that satisfy every equation in the system. • The coordinates of points of intersection in any system of equations are solutions to the system. • Real-world problems can be interpreted, represented, and solved using systems of equations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Predict the number of solutions to a nonlinear system of two equations. • ~~Identify nonlinear systems of equations as linear-quadratic or quadratic-quadratic.~~ • ~~Visualize a nonlinear system of two equations, and predict the number of solutions, using the graphing calculator.~~ • Solve a linear-quadratic system of two equations algebraically and graphically. • Solve a quadratic-quadratic system of two equations algebraically and graphically.

TOPIC: FUNCTIONS

ALGEBRA II
STANDARD AII.6

The student will recognize the general shape of function (absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic) families and will convert between graphic and symbolic forms of functions. A transformational approach to graphing will be employed. Graphing calculators will be used as a tool to investigate the shapes and behaviors of these functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The graphs/equations for a family of functions can be determined using a transformational approach. • Transformations of graphs include translations, reflections, and dilations. • A parent graph is an anchor graph from which other graphs are derived with transformations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize graphs of parent functions. • Given a transformation of a parent function, identify the graph of the transformed function. • Given the equation and using a transformational approach, graph a function. • Given the graph of a function, identify the parent function. • Given the graph of a function, identify the transformations that map the preimage to the ~~pre~~image in order to determine the equation of the image. • Using a transformational approach, write the equation of a function given its graph. • ~~Recognize graphs of parent functions for linear, quadratic, absolute value, step, and exponential functions.~~ • ~~Given an equation of a function, identify the function as linear, quadratic, absolute value, step, or exponential.~~

TOPIC: FUNCTIONS

ALGEBRA II
STANDARD AII.6

The student will recognize the general shape of function (absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic) families and will convert between graphic and symbolic forms of functions. A transformational approach to graphing will be employed. Graphing calculators will be used as a tool to investigate the shapes and behaviors of these functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
	• ~~Write the equation of a linear (slope-intercept form), quadratic ([*h*, *k*] form), absolute value, step, or exponential function, given the graph of the parent function or an integral translation of a parent function.~~ • ~~Given an equation, graph a linear, quadratic, absolute value, step, or exponential function with the aid of a graphing calculator.~~ • ~~Using the general shape of the graph of a function, identify the family of graphs to which a particular graph belongs. Characteristics of a graph may include the *x*- and *y*-intercepts, number and location of turning points, and end behaviors.~~

TOPIC: FUNCTIONS

ALGEBRA II
STANDARD AII.7

The student will investigate and analyze functions algebraically and graphically. Key concepts include

a) domain and range, including limited and discontinuous domains and ranges;
b) zeros;
c) *x*- and *y*-intercepts;
d) intervals in which a function is increasing or decreasing;
e) asymptotes;
f) end behavior;
g) inverse of a function; and
h) composition of multiple functions.

Graphing calculators will be used as a tool to assist in investigation of functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Functions may be used to model real-world situations. • The domain and range of a function may be restricted algebraically or by the real-world situation modeled by the function. • A function can be described on an interval as increasing, decreasing, or constant. • ~~Exponential and logarithmic functions are either strictly increasing or strictly decreasing.~~ • Asymptotes may describe both local and global behavior of functions. • End behavior describes a function as *x* approaches positive and negative infinity. • A zero of a function is a value of *x* that makes f(x) equal zero.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the domain, range, zeros, and ~~inverse~~intercepts of a function presented algebraically or graphically. • Describe restricted/discontinuous domains and ranges. • ~~Distinguish between relations and functions that are expressed algebraically and graphically.~~ • ~~Use interchange of variables to find the inverse of a function~~. • ~~Given the graphs, recognize that exponential and logarithmic functions are inverses of each other.~~ • Given the graph of a function, identify intervals on which the function is increasing and decreasing.

TOPIC: FUNCTIONS

ALGEBRA II
STANDARD AII.7

The student will investigate and analyze functions algebraically and graphically. Key concepts include

a) domain and range, including limited and discontinuous domains and ranges;
b) zeros;
c) *x*- and *y*-intercepts;
d) intervals in which a function is increasing or decreasing;
e) asymptotes;
f) end behavior;
g) inverse of a function; and
h) composition of multiple functions.

Graphing calculators will be used as a tool to assist in investigation of functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Functions describe the relationship between two variables.~~ • ~~Graphs of functions that are inverses of each other are reflections across the line $y = x$.~~ • ~~The composition of a function and its inverse is the identity function.~~ • ~~Functions arise from practical situations.~~ • If (a, b) is an element of a function, then (b, a) is an element of the inverse of the function. • Exponential ($y = a^x$) and logarithmic ($y = \log_a x$) functions are inverses of each other. • Functions can be combined using composition of functions. • ~~Shapes and behavior of graphs of polynomials can be determined~~	• Find the equations of vertical and horizontal asymptotes of functions. • Describe the end behavior of a function. • ~~Recognize~~ • Find the inverse of a function. • ~~Find the value of a function for a given element from the domain.~~ • Graph the inverse of a function as a reflection across the line $y = x$. • Investigate exponential and logarithmic functions, using the graphing calculator. • Convert between logarithmic and exponential forms of an equation with bases consisting of natural numbers.

TOPIC: FUNCTIONS

ALGEBRA II
STANDARD AII.7

The student will investigate and analyze functions algebraically and graphically. Key concepts include

a) domain and range, including limited and discontinuous domains and ranges;
b) zeros;
c) *x*- and *y*-intercepts;
d) intervals in which a function is increasing or decreasing;
e) asymptotes;
f) end behavior;
g) inverse of a function; and
h) composition of multiple functions.

Graphing calculators will be used as a tool to assist in investigation of functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
~~by analyzing transformations of parent functions.~~ • ~~Using graphing calculators is a strategy for investigating the shape and behavior of polynomial functions.~~	• Find the composition of two functions. • Use composition of functions to verify two functions are inverses. • ~~Investigate the shape and behavior of linear, quadratic, and cubic functions. Behaviors will include intercepts, number of turning points, and end behavior.~~ • ~~Investigate the shape and behavior of exponential ($a^x = y$) and logarithmic ($\log_b x = y$) functions, including intercepts and end behavior.~~

TOPIC: FUNCTIONS

ALGEBRA II
STANDARD AII.8

The student will investigate and describe the relationships among solutions of an equation, zeros of a function, *x*-intercepts of a graph, and factors of a polynomial expression.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The *Fundamental Theorem of Algebra* states that, including complex and repeated solutions, an nth degree polynomial equation has exactly n roots (solutions). • The following statements are equivalent: – k is a zero of the polynomial function f; – $(x - k)$ is a factor of $f(x)$; – k is a solution of the polynomial equation $f(x) = 0$; and – k is an x-intercept for the graph of $y = f(x)$.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe the relationships among solutions of an equation, zeros of a function, x-intercepts of a graph, and factors of a polynomial expression. • Define a polynomial function, given its zeros. • Determine ~~the~~a factored form of a polynomial expression from the x-intercepts of the graph of its corresponding function. • For a function, identify zeros of multiplicity greater than 1 and describe the effect of those zeros on the graph of the function. • Given a polynomial equation, determine the number of real solutions and nonreal solutions.

TOPIC: STATISTICS

ALGEBRA II
STANDARD AII.9

The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data and scatterplots may indicate patterns that can be modeled with an algebraic equation. • Graphing calculators can be used to collect, organize, picture, and create an algebraic model of the data. • Data that fit polynomial ($f(x) = a_n x^n + a_{n-1}x^{n-1} + ... + a_1 x + a_0$, where n is a nonnegative integer, and the coefficients are real numbers), exponential ($y = b^x$), and logarithmic ($y = \log_b x$) models arise from real-world situations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Collect and analyze data. • Investigate scatterplots to determine if patterns exist and then identify the patterns. • Find an equation for the curve of best fit for data, using a graphing calculator. Models will include ~~linear, quadratic~~, polynomial, exponential, and logarithmic functions. • Make predictions, using data, scatterplots, or the equation of the curve of best fit. • Given a set of data, determine the model that would best describe the data.

TOPIC: STATISTICS

ALGEBRA II
STANDARD AII.10

The student will identify, create, and solve real-world problems involving inverse variation, joint variation, and a combination of direct and inverse variations.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Practical~~ Real-world problems can be modeled and solved by using inverse variation, joint variation, and a combination of direct and inverse variations. • Joint variation is a combination of direct variations.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • ~~Translate "y varies jointly as x and z" as $y = kxz$.~~ • Translate "y varies jointly as x and z" as $y = kxz$. • ~~Translate "y is directly proportional to x" as $y = kx$.~~ • Translate "y is directly proportional to x" as $y = kx$. • ~~Translate "y is inversely proportional to x" as $y = \frac{k}{x}$.~~ • Translate "y is inversely proportional to x" as $y = \frac{k}{x}$. • Given a situation, determine the value of the constant of proportionality~~, k, given initial conditions for x and y~~. • Set up and solve ~~practical~~ problems, including real-world problems, ~~using~~ involving inverse variation, joint variation, and a combination of direct and inverse variations.

TOPIC: STATISTICS

ALGEBRA II
STANDARD AII.11

The student will identify properties of a normal distribution and apply those properties to determine probabilities associated with areas under the standard normal curve.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~The~~A normal distribution curve is a ~~family of~~ symmetrical, bell-shaped curve~~s~~ defined by the mean and the standard deviation of a data set. The mean is located on the line of symmetry of the curve. • Areas under the curve represent probabilities associated with continuous distributions. • The normal curve is a probability distribution and the total area under the curve is 1. • For a normal distribution, approximately 68 percent of the data fall within one standard deviation of the mean, approximately 95 percent of the data fall within two standard deviations of the mean, and approximately 99.7 percent of the data fall within three standard deviations of the mean. • The mean of the data in a standard normal ~~density function~~ distribution is 0 and the standard deviation is 1. ~~This allows for the comparison of unlike data.~~ • The standard normal curve allows for the comparison of data from different normal distributions. • A z-score is a measure of position derived from the mean and standard deviation of data.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the properties of a normal probability distribution. • Describe how the standard deviation and the mean affect the graph of the normal distribution. • Compare two sets of normally distributed data using a standard normal ~~curve~~distribution and z-scores. • Represent probability as area under the curve of a standard normal probability distribution. • Use the graphing calculator or a standard normal probability table to determine probabilities or percentiles based on z-scores.

TOPIC: STATISTICS

ALGEBRA II
STANDARD AII.11

The student will identify properties of a normal distribution and apply those properties to determine probabilities associated with areas under the standard normal curve.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A z-score expresses, in standard deviation units, how far an element falls from the mean of the data set. • A z-score is a derived score from a given normal distribution. • A standard normal distribution is the set of all z-scores.	

TOPIC: STATISTICS

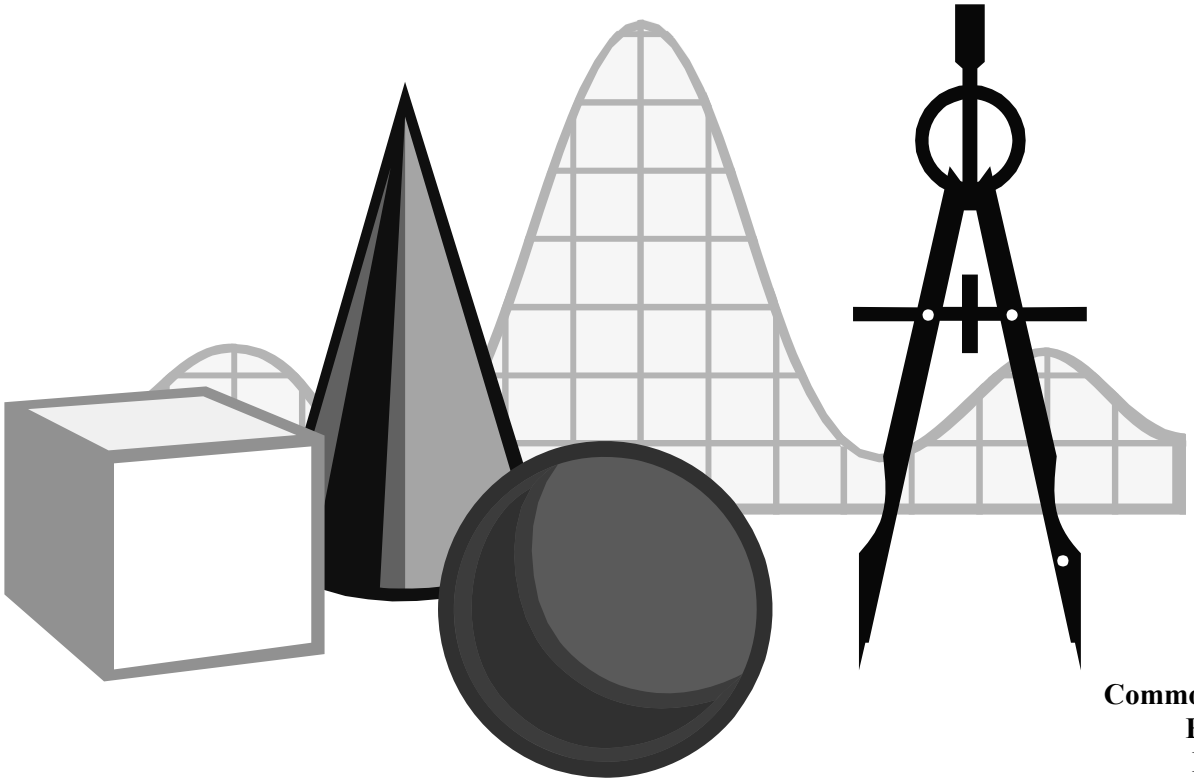
ALGEBRA II
STANDARD AII.12

The student will compute and distinguish between permutations and combinations and use technology for applications.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The *Fundamental Counting Principle* states that if one decision can be made *n* ways and another can be made *m* ways, then the two decisions can be made *nm* ways. • *Permutations* are used to calculate the number of possible arrangements of objects. • *Combinations* are used to calculate the number of possible selections of objects without regard to the order selected.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and contrast permutations and combinations. • Calculate the number of permutations of *n* objects taken *r* at a time. • Calculate the number of combinations of *n* objects taken *r* at a time. • Use permutations and combinations as counting techniques to solve real-world problems.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Trigonometry



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Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

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Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into two columns: Essential Understandings and Essential Knowledge and Skills~~ and Essential Understandings~~. The purpose of each column is explained below.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

The Curriculum Framework serves as a guide for ~~SOL~~ Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build mathematical expertise.

TOPIC: TRIANGULAR AND CIRCULAR TRIGONOMETRIC FUNCTIONS

TRIGONOMETRY
STANDARD T.1

The student, given a point other than the origin on the terminal side of the angle, will use the definitions of the six trigonometric functions to find the sine, cosine, tangent, cotangent, secant, and cosecant of the angle in standard position. Trigonometric functions defined on the unit circle will be related to trigonometric functions defined in right triangles.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Triangular trigonometric function definitions are related to circular trigonometric function definitions. • Both degrees and radians are units for measuring angles. • Drawing an angle in standard position will force the terminal side to lie in a specific quadrant. • A point on the terminal side of an angle determines a reference triangle from which the values of the six trigonometric functions may be derived.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Define the six triangular trigonometric functions of an angle in a right triangle. • Define the six circular trigonometric functions of an angle in standard position. • Make the connection between the triangular and circular trigonometric functions. • Recognize and draw an angle in standard position. • Show how a point on the terminal side of an angle determines a reference triangle.

TOPIC: TRIANGULAR AND CIRCULAR TRIGONOMETRIC FUNCTIONS

TRIGONOMETRY
STANDARD T.2

The student, given the value of one trigonometric function, will find the values of the other trigonometric functions, using the definitions and properties of the trigonometric functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• If one trigonometric function value is known, then a triangle can be formed to use in finding the other five trigonometric function values. • Knowledge of the unit circle is a useful tool for finding all six trigonometric values for special angles.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Given one trigonometric function value, find the other five trigonometric function values. • Develop the unit circle, using both degrees and radians. • Solve problems, using the circular function definitions and the properties of the unit circle. • Recognize the connections between the coordinates of points on a unit circle and – coordinate geometry; – cosine and sine values; and – lengths of sides of special right triangles (30°-60°-90° and 45°-45°-90°).

TOPIC: TRIANGULAR AND CIRCULAR TRIGONOMETRIC FUNCTIONS

TRIGONOMETRY
STANDARD T.3

The student will find, without the aid of a calculator, the values of the trigonometric functions of the special angles and their related angles as found in the unit circle. This will include converting angle measures from radians to degrees and vice versa.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Special angles are widely used in mathematics. • Unit circle properties will allow special angle and related angle trigonometric values to be found without the aid of a calculator. • Degrees and radians are units of angle measure. • A radian is the measure of the central angle that is determined by an arc whose length is the same as the radius of the circle.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find trigonometric function values of special angles and their related angles in both degrees and radians. • Apply the properties of the unit circle without using a calculator. • Use a conversion factor to convert from radians to degrees and vice versa without using a calculator.

TOPIC: INVERSE TRIGONOMETRIC FUNCTIONS

TRIGONOMETRY
STANDARD T.4

The student will find, with the aid of a calculator, the value of any trigonometric function and inverse trigonometric function.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The trigonometric function values of any angle can be found by using a calculator. • The inverse trigonometric functions can be used to find angle measures whose trigonometric function values are known. • Calculations of inverse trigonometric function values can be related to the triangular definitions of the trigonometric functions.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use a calculator to find the trigonometric function values of any angle in either degrees or radians. • Define inverse trigonometric functions. • Find angle measures by using the inverse trigonometric functions when the trigonometric function values are given.

TOPIC: TRIGONOMETRIC IDENTITIES

TRIGONOMETRY
STANDARD T.5

The student will verify basic trigonometric identities and make substitutions, using the basic identities.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Trigonometric identities can be used to simplify trigonometric expressions, equations, or identities. • Trigonometric identity substitutions can help solve trigonometric equations, verify another identity, or simplify trigonometric expressions.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use trigonometric identities to make algebraic substitutions to simplify and verify trigonometric identities. The basic trigonometric identities include – reciprocal identities; – Pythagorean identities; – sum and difference identities; – double-angle identities; and – half-angle identities.

TOPIC: TRIGONOMETRIC EQUATIONS, GRAPHS, AND PRACTICAL PROBLEMS

TRIGONOMETRY
STANDARD T.6

The student, given one of the six trigonometric functions in standard form, will

a) state the domain and the range of the function;
b) determine the amplitude, period, phase shift, vertical shift, and asymptotes;
c) sketch the graph of the function by using transformations for at least a two-period interval; and
d) investigate the effect of changing the parameters in a trigonometric function on the graph of the function.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The domain and range of a trigonometric function determine the scales of the axes for the graph of the trigonometric function. • The amplitude, period, phase shift, and vertical shift are important characteristics of the graph of a trigonometric function, and each has a specific purpose in applications using trigonometric equations. • The graph of a trigonometric function can be used to display information about the periodic behavior of a real-world situation, such as wave motion or the motion of a Ferris wheel.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine the amplitude, period, phase shift, and vertical shift of a trigonometric function from the equation of the function and from the graph of the function. • Describe the effect of changing A, B, C, or D in the standard form of a trigonometric equation {e.g., $y = A \sin (Bx + C) + D$ or $y = A \cos [B(x + C)] + D$}. • State the domain and the range of a function written in standard form {e.g., $y = A \sin (Bx + C) + D$ or $y = A \cos [B(x + C)] + D$}. • Sketch the graph of a function written in standard form {e.g., $y = A \sin (Bx + C) + D$ or $y = A \cos [B(x + C)] + D$} by using transformations for at least one period or one cycle.

TOPIC: INVERSE TRIGONOMETRIC FUNCTIONS

TRIGONOMETRY
STANDARD T.7

The student will identify the domain and range of the inverse trigonometric functions and recognize the graphs of these functions. Restrictions on the domains of the inverse trigonometric functions will be included.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Restrictions on the domains of some inverse trigonometric functions exist.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find the domain and range of the inverse trigonometric functions. • Use the restrictions on the domains of the inverse trigonometric functions in finding the values of the inverse trigonometric functions. • Identify the graphs of the inverse trigonometric functions.

TOPIC: TRIGONOMETRIC EQUATIONS, GRAPHS, AND PRACTICAL PROBLEMS

TRIGONOMETRY
STANDARD T.8

The student will solve trigonometric equations that include both infinite solutions and restricted domain solutions and solve basic trigonometric inequalities.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Solutions for trigonometric equations will depend on the domains. • A calculator can be used to find the solution of a trigonometric equation as the points of intersection of the graphs when one side of the equation is entered in the calculator as Y_1 and the other side is entered as Y_2.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Solve trigonometric equations with restricted domains algebraically and by using a graphing utility. • Solve trigonometric equations with infinite solutions algebraically and by using a graphing utility. • Check for reasonableness of results, and verify algebraic solutions, using a graphing utility.

TOPIC: TRIGONOMETRIC EQUATIONS, GRAPHS, AND PRACTICAL PROBLEMS

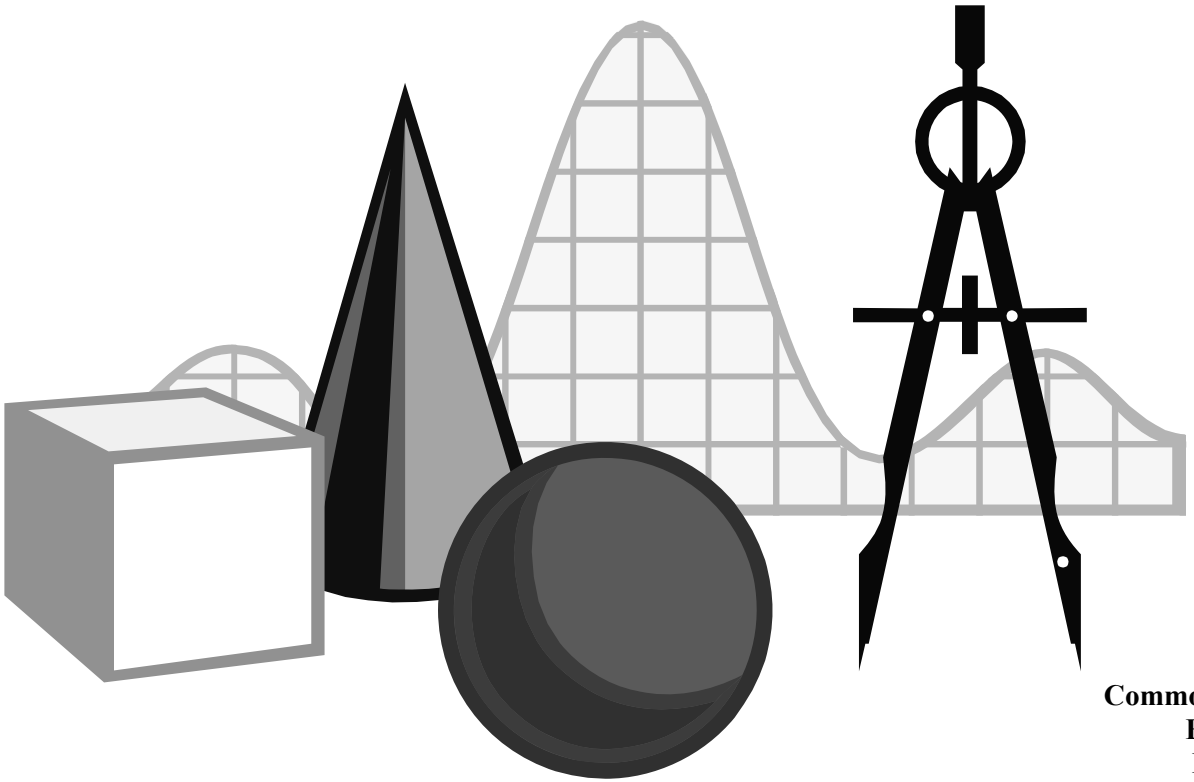
TRIGONOMETRY
STANDARD T.9

The student will identify, create, and solve real-world problems involving triangles. Techniques will include using the trigonometric functions, the Pythagorean Theorem, the Law of Sines, and the Law of Cosines.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A ~~practical~~ real-world problem may be solved by using one of a variety of techniques associated with triangles.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Write a ~~practical~~ real-world problem involving triangles. • Solve ~~practical~~ real-world problems involving triangles. • Use the trigonometric functions, Pythagorean Theorem, Law of Sines, and Law of Cosines to solve ~~practical~~ real-world problems. • Use the trigonometric functions to model real-world situations. • Identify a solution technique that could be used with a given problem.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Discrete Mathematics



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Board of Education
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TOPIC: GRAPHS

DISCRETE MATHEMATICS
STANDARD DM.1

The student will model problems, using vertex-edge graphs. The concepts of valence, connectedness, paths, planarity, and directed graphs will be investigated. Adjacency matrices and matrix operations will be used to solve problems (e.g., food chains, number of paths).

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A tournament is a digraph that results from giving directions to the edges of a complete graph. • Adjacent vertices are connected by an edge. • In a connected graph, every pair of vertices is adjacent.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find the valence of each vertex in a graph. • Use graphs to model situations in which the vertices represent objects, and edges (drawn between vertices) represent a particular relationship between objects. • Represent the vertices and edges of a graph as an adjacency matrix, and use the matrix to solve problems. • Investigate and describe valence and connectedness. • Determine whether a graph is planar or nonplanar. • Use directed graphs (digraphs) to represent situations with restrictions in traversal possibilities.

TOPIC: GRAPHS

DISCRETE MATHEMATICS
STANDARD DM.2

The student will solve problems through investigation and application of circuits, cycles, Euler Paths, Euler Circuits, Hamilton Paths, and Hamilton Circuits. Optimal solutions will be sought using existing algorithms and student-created algorithms.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Euler's Theorem states: If G is a connected graph and all its valences are even, then G has an Euler Circuit. • Pairs of routes (circuits) correspond to the same Hamilton Circuit because one route can be obtained from the other by traversing the vertices in reverse order. There are $\frac{(n-1)!}{2}$ Hamilton Circuits. • A multigraph is connected if there is a path between every pair of vertices.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine if a graph has an Euler Circuit or Path, and find it. • Determine if a graph has a Hamilton Circuit or Path, and find it. • Count the number of Hamilton Circuits for a complete graph with n vertices. • Use the Euler Circuit algorithm to solve optimization problems.

TOPIC: GRAPHS

DISCRETE MATHEMATICS
STANDARD DM.3

The student will apply graphs to conflict-resolution problems, such as map coloring, scheduling, matching, and optimization. Graph coloring and chromatic number will be used.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Every planar graph has a chromatic number that is less than or equal to four (the four-color-map theorem). • A graph can be colored with two colors if and only if it contains no cycle of odd length. • The chromatic number of a graph cannot exceed one more than the maximum number of degrees of the vertices of the graph.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Model projects consisting of several subtasks, using a graph. • Use graphs to resolve conflicts that arise in scheduling.

TOPIC: GRAPHS

DISCRETE MATHEMATICS
STANDARD DM.4

The student will apply algorithms, such as Kruskal's, Prim's, or Dijkstra's, relating to trees, networks, and paths. Appropriate technology will be used to determine the number of possible solutions and generate solutions when a feasible number exists.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A spanning tree of a connected graph *G* is a tree that is a subgraph of *G* and contains every vertex of *G*.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use Kruskal's Algorithm to find the shortest spanning tree of a connected graph. • Use Prim's Algorithm to find the shortest spanning tree of a connected graph. • Use Dijkstra's Algorithm to find the shortest spanning tree of a connected graph.

TOPIC: ELECTION THEORY AND FAIR DIVISION

DISCRETE MATHEMATICS
STANDARD DM.7

The student will analyze and describe the issue of fair division (e.g., cake cutting, estate division). Algorithms for continuous and discrete cases will be applied.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Group decision making combines the wishes of many to yield a single fair result. • A fair division problem may be discrete or continuous. • The success of the estate division algorithm requires that each heir be capable of placing a value on each object in the estate. • A fair division problem consists of *n* individuals (players) who must partition some set of goods, *s*, into *n* disjoint sets.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Investigate and describe situations involving discrete division (e.g., estate division). • Use an algorithm for fair division for a group of indivisible objects. • Investigate and describe situations involving continuous division of an infinitely divisible set (e.g., cake cutting). • Use an algorithm for fair division of an infinitely divisible set.

TOPIC: ELECTION THEORY AND FAIR DIVISION

DISCRETE MATHEMATICS
STANDARD DM.8

The student will investigate and describe weighted voting and the results of various election methods. These may include approval and preference voting as well as plurality, majority, run-off, sequential run-off, Borda count, and Condorcet winners.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Historically, popular voting methods have often led to counterintuitive results. • A candidate who wins over every other candidate in a one-on-one ballot is a Condorcet winner. • A Borda count assigns points in descending order to each voter's subsequent ranking and then adds these points to arrive at a group's final ranking. • To select a voting system is to compromise between the shortcomings inherent in each system.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Determine in how many different ways a voter can rank choices. • Investigate and describe the following voting procedures: – weighted voting; – plurality; – majority; – sequential (winners run off); – sequential (losers are eliminated); – Borda count; and – Condorcet winner. • Compare and contrast different voting procedures. • Describe the possible effects of approval voting, insincere and sincere voting, a preference schedule, and strategic voting on the election outcome.

TOPIC: ELECTION THEORY AND FAIR DIVISION

DISCRETE MATHEMATICS
STANDARD DM.9

The student will identify apportionment inconsistencies that apply to issues such as salary caps in sports and allocation of representatives to Congress. Historical and current methods will be compared.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The apportionment of Congressional representatives is based on the latest census.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and contrast the Hamilton and Jefferson methods of political apportionment with the Hill-Huntington method (currently in use in the U.S. House of Representatives) and the Webster-Willcox method. • Solve allocation problems, using apportionment methods. • Investigate and describe how salary caps affect apportionment.

TOPIC: COMPUTER MATHEMATICS

DISCRETE MATHEMATICS
STANDARD DM.11

The student will describe and apply sorting algorithms and coding algorithms used in sorting, processing, and communicating information. These will include

a) bubble sort, merge sort, and network sort; and
b) ISBN, UPC, Zip, and banking codes.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A bubble sort orders elements of an array by comparing adjacent elements. • A merge sort combines two sorted lists into a single sorted list. • Coding algorithms must account for the number of possible codes within the constraints of the coding system.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Select and apply a sorting algorithm, such as a – bubble sort; – merge sort; and – network sort. • Describe and apply a coding algorithm, such as – ISBN numbers; – UPC codes; – Zip codes; and – banking codes.

TOPIC: COMPUTER MATHEMATICS

DISCRETE MATHEMATICS
STANDARD DM.12

The student will select, justify, and apply an appropriate technique to solve a logic problem. Techniques will include Venn diagrams, truth tables, and matrices.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Two-valued (Boolean) algebra serves as a workable method for interpreting the logical truth and falsity of compound statements. • Venn diagrams provide pictures of topics in set theory, such as intersection and union, mutually exclusive sets, and the empty set.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Generate truth tables that encode the truth and falsity of two or more statements. • Use Venn diagrams to codify and solve logic problems. • Use matrices as arrays of data to solve logic problems.

TOPIC: RECURSION AND OPTIMIZATION

DISCRETE MATHEMATICS
STANDARD DM.5

The student will use algorithms to schedule tasks in order to determine a minimum project time. The algorithms will include critical path analysis, the list-processing algorithm, and student-created algorithms.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Critical path scheduling sometimes yields optimal solutions.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Specify in a digraph the order in which tests are to be performed. • Identify the critical path to determine the earliest completion time (minimum project time). • Use the list-processing algorithm to determine an optimal schedule. • Create and test scheduling algorithms.

TOPIC: RECURSION AND OPTIMIZATION

DISCRETE MATHEMATICS
STANDARD DM.6

The student will solve linear programming problems. Appropriate technology will be used to facilitate the use of matrices, graphing techniques, and the Simplex method of determining solutions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Linear programming models an optimization process. • A linear programming model consists of a system of constraints and an objective quantity that can be maximized or minimized. • Any maximum or minimum value for a system of inequalities will occur at a corner point of a feasible region.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Model real-world problems with systems of linear inequalities. • Identify the feasibility region of a system of linear inequalities with no more than four constraints. • Identify the coordinates of the corner points of a feasibility region. • Find the maximum or minimum value of the system. • Describe the meaning of the maximum or minimum value in terms of the original problem.

TOPIC: RECURSION AND OPTIMIZATION

DISCRETE MATHEMATICS
STANDARD DM.10

The student will use the recursive process and difference equations with the aid of appropriate technology to generate

a) compound interest;
b) sequences and series;
c) fractals;
d) population growth models; and
e) the Fibonacci sequence.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Recursion is a process that creates new objects from existing objects that were created by the same process. • A fractal is a figure whose dimension is not a whole number. • Fractals are self-similar.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use finite differences and recursion to model compound interest and population growth situations. • Model arithmetic and geometric sequences and series recursively. • Compare and contrast the recursive process, and create fractals. • Compare and contrast the recursive process and the Fibonacci sequence. • Find a recursive relationship that generates the Fibonacci sequence.

TOPIC: RECURSION AND OPTIMIZATION

DISCRETE MATHEMATICS
STANDARD DM.13

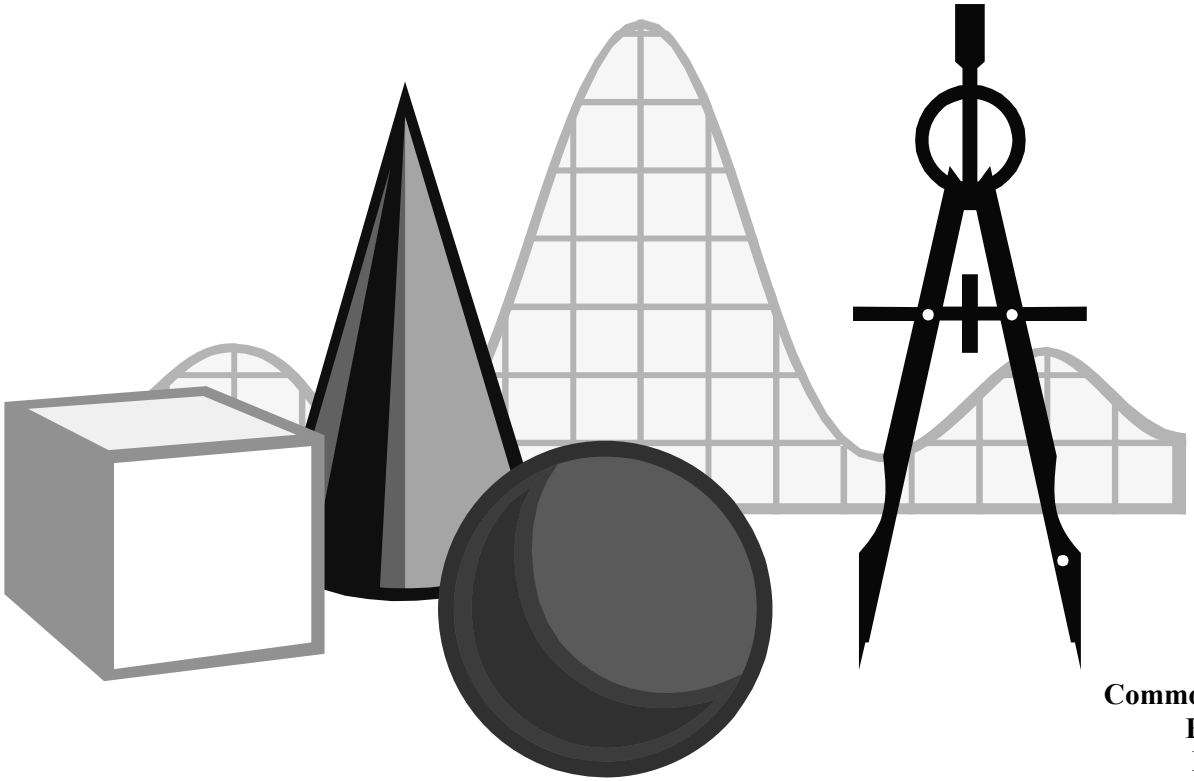
The student will apply the formulas of combinatorics in the areas of

a) the Fundamental (Basic) Counting Principle;
b) knapsack and bin-packing problems;
c) permutations and combinations; and
d) the pigeonhole principle.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The branch of mathematics that addresses the number of ways objects can be arranged or combined is combinatorics. • If n and r are positive integers and $n \geq r$, $$n\,P\,r = \frac{n!}{(n-r)!} \quad \text{and} \quad n\,C\,r = \frac{n!}{r!\,(n-r)!}.$$ • A bin-packing problem determines the minimum number of containers of fixed volume (bins) required to hold a set of objects. • A knapsack problem determines the most valuable set of objects that fit into a container (knapsack) of fixed volume. • Bin packing and knapsack packing are optimization techniques.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find the number of combinations possible when subsets of r elements are selected from a set of n elements without regard to order. • Use the Fundamental (Basic) Counting Principle to determine the number of possible outcomes of an event. • Use the knapsack and bin-packing algorithms to solve real-world problems. • Find the number of permutations possible when r objects selected from n objects are ordered. • Use the pigeonhole principle to solve packing problems to facilitate proofs.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Probability and Statistics



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Board of Education
Richmond, Virginia
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Virginia 2009 *Mathematics Standards of Learning* Curriculum Framework
Introduction

The 2009 *Mathematics Standards of Learning* Curriculum Framework is a companion document to the 2009 *Mathematics Standards of Learning* and amplifies the *Mathematics Standards of Learning* by defining the content knowledge, skills, and understandings that are measured by the Standards of Learning assessments. The Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers in their lesson planning by identifying essential understandings, defining essential content knowledge, and describing the intellectual skills students need to use. This supplemental framework delineates in greater specificity the content that all teachers should teach and all students should learn.

Each topic in the *Mathematics Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into two columns: Essential Understandings and Essential Knowledge and Skills~~ and Essential Understandings~~. The purpose of each column is explained below.

Essential Understandings
This section delineates the key concepts, ideas and mathematical relationships that all students should grasp to demonstrate an understanding of the Standards of Learning.

Essential Knowledge and Skills
Each ~~S~~standard is expanded in the Essential Knowledge and Skills column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

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TOPIC: DESCRIPTIVE STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.1

The student will analyze graphical displays of univariate data, including dotplots, stemplots, and histograms, to identify and describe patterns and departures from patterns, using central tendency, spread, clusters, gaps, and outliers. Appropriate technology will be used to create graphical displays.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data are collected for a purpose and have meaning in a context. • Measures of central tendency describe how the data cluster or group. • Measures of dispersion describe how the data spread (disperse) around the center of the data. • Graphical displays of data may be analyzed informally. • Data analysis must take place within the context of the problem.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Create and interpret graphical displays of data, including dotplots, stem-and-leaf plots, and histograms. • Examine graphs of data for clusters and gaps, and relate those phenomena to the data in context. • Examine graphs of data for outliers, and explain the outlier(s) within the context of the data. • Examine graphs of data and identify the central tendency of the data as well as the spread. Explain the central tendency and the spread of the data within the context of the data.

TOPIC: DESCRIPTIVE STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.2

The student will analyze numerical characteristics of univariate data sets to describe patterns and departure from patterns, using mean, median, mode, variance, standard deviation, interquartile range, range, and outliers.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data are collected for a purpose and have meaning within a context. • Analysis of the descriptive statistical information generated by a univariate data set should include the interplay between central tendency and dispersion as well as among specific measures. • Data points identified algorithmically as outliers should not be excluded from the data unless sufficient evidence exists to show them to be in error.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Interpret mean, median, mode, range, interquartile range, variance, and standard deviation of a univariate data set in terms of the problem's context. • Identify possible outliers, using an algorithm. • Explain the influence of outliers on a univariate data set. • Explain ways in which standard deviation addresses dispersion by examining the formula for standard deviation.

TOPIC: DESCRIPTIVE STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.3

The student will compare distributions of two or more univariate data sets, analyzing center and spread (within group and between group variations), clusters and gaps, shapes, outliers, or other unusual features.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data are collected for a purpose and have meaning in a context. • Statistical tendency refers to typical cases but not necessarily to individual cases.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and contrast two or more univariate data sets by analyzing measures of center and spread within a contextual framework. • Describe any unusual features of the data, such as clusters, gaps, or outliers, within the context of the data. • Analyze in context kurtosis and skewness in conjunction with other descriptive measures.

TOPIC: DESCRIPTIVE STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.4

The student will analyze scatterplots to identify and describe the relationship between two variables, using shape; strength of relationship; clusters; positive, negative, or no association; outliers; and influential points.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A scatterplot serves two purposes: – to determine if there is a useful relationship between two variables, and – to determine the family of equations that describes the relationship. • Data are collected for a purpose and have meaning in a context. • Association between two variables considers both the direction and strength of the association. • The strength of an association between two variables reflects how accurately the value of one variable can be predicted based on the value of the other variable. • Outliers are observations with large residuals and do not follow the pattern apparent in the other data points.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Examine scatterplots of data, and describe skewness, kurtosis, and correlation within the context of the data. • Describe and explain any unusual features of the data, such as clusters, gaps, or outliers, within the context of the data. • Identify influential data points (observations that have great effect on a line of best fit because of extreme *x*-values) and describe the effect of the influential points.

TOPIC: DESCRIPTIVE STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.5

The student will find and interpret linear correlation, use the method of least squares regression to model the linear relationship between two variables, and use the residual plots to assess linearity.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data are collected for a purpose and have meaning in a context. • Least squares regression generates the equation of the line that minimizes the sum of the squared distances from the data points to the line. • Each data point may be considered to be comprised of two parts: fit (the part explained by the model) and residual (the result of chance variation or of variables not measured). • Residual = Actual – Fitted • A correlation coefficient measures the degree of association between two variables that are related linearly. • Two variables may be strongly associated without a cause-and-effect relationship existing between them.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Calculate a correlation coefficient. • Explain how the correlation coefficient, *r*, measures association by looking at its formula. • Use regression lines to make predictions, and identify the limitations of the predictions. • Use residual plots to determine if a linear model is satisfactory for describing the relationship between two variables. • Describe the errors inherent in extrapolation beyond the range of the data. • Use least squares regression to find the equation of the line of best fit for a set of data. • Explain how least squares regression generates the equation of the line of best fit by examining the formulas used in computation.

TOPIC: DESCRIPTIVE STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.6

The student will make logarithmic and power transformations to achieve linearity.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A logarithmic transformation reduces positive skewness because it compresses the upper tail of the distribution while stretching the lower tail. • Nonlinear transformations do not preserve relative spacing between data points.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Apply a logarithmic transformation to data. • Explain how a logarithmic transformation works to achieve a linear relationship between variables. • Apply a power transformation to data. • Explain how a power transformation works to achieve a linear relationship between variables.

TOPIC: DESCRIPTIVE STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.7

The student, using two-way tables, will analyze categorical data to describe patterns and departure from patterns and to find marginal frequency and relative frequencies, including conditional frequencies.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data are collected for a purpose and have meaning in a context. • Simpson's paradox refers to the fact that aggregate proportions can reverse the direction of the relationship seen in the individual parts. • Two categorical variables are independent if the conditional frequencies of one variable are the same for every category of the other variable.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Produce a two-way table as a summary of the information obtained from two categorical variables. • Calculate marginal, relative, and conditional frequencies in a two-way table. • Use marginal, relative, and conditional frequencies to analyze data in two-way tables within the context of the data.

TOPIC: DATA COLLECTION

PROBABILITY AND STATISTICS
STANDARD PS.8

The student will describe the methods of data collection in a census, sample survey, experiment, and observational study and identify an appropriate method of solution for a given problem setting.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The value of a sample statistic varies from sample to sample if the simple random samples are taken repeatedly from the population of interest. • Poor data collection can lead to misleading and meaningless conclusions.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and contrast controlled experiments and observational studies and the conclusions one can draw from each. • Compare and contrast population and sample and parameter and statistic. • Identify biased sampling methods. • Describe simple random sampling. • Select a data collection method appropriate for a given context.

TOPIC: DATA COLLECTION

PROBABILITY AND STATISTICS
STANDARD PS.9

The student will plan and conduct a survey. The plan will address sampling techniques (e.g., simple random and stratified) and methods to reduce bias.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The purpose of sampling is to provide sufficient information so that population characteristics may be inferred. • Inherent bias diminishes as sample size increases.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Investigate and describe sampling techniques, such as simple random sampling, stratified sampling, and cluster sampling. • Determine which sampling technique is best, given a particular context. • Plan a survey to answer a question or address an issue. • Given a plan for a survey, identify possible sources of bias, and describe ways to reduce bias. • Design a survey instrument. • Conduct a survey.

TOPIC: DATA COLLECTION

PROBABILITY AND STATISTICS
STANDARD PS.10

The student will plan and conduct an experiment. The plan will address control, randomization, and measurement of experimental error.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Experiments must be carefully designed in order to detect a cause-and-effect relationship between variables. • Principles of experimental design include comparison with a control group, randomization, and blindness.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Plan and conduct an experiment. The experimental design should address control, randomization, and minimization of experimental error.

TOPIC: PROBABILITY

PROBABILITY AND STATISTICS
STANDARD PS.11

The student will identify and describe two or more events as complementary, dependent, independent, and/or mutually exclusive.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The complement of event A consists of all outcomes in which event A does not occur. • Two events, A and B, are independent if the occurrence of one does not affect the probability of the occurrence of the other. If A and B are not independent, then they are said to be dependent. • Events A and B are mutually exclusive if they cannot occur simultaneously.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Define and give contextual examples of complementary, dependent, independent, and mutually exclusive events. • Given two or more events in a problem setting, determine if the events are complementary, dependent, independent, and/or mutually exclusive.

TOPIC: PROBABILITY

PROBABILITY AND STATISTICS
STANDARD PS.12

The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of Large Numbers concept, the addition rule, and the multiplication rule.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Data are collected for a purpose and have meaning in a context. • Venn diagrams may be used to find conditional probabilities. • The "Law of Large Numbers" states that as a procedure is repeated again and again, the relative frequency probability of an event tends to approach the actual probability.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Calculate relative frequency and expected frequency. • Find conditional probabilities for dependent, independent, and mutually exclusive events.

TOPIC: PROBABILITY

PROBABILITY AND STATISTICS
STANDARD PS.13

The student will develop, interpret, and apply the binomial probability distribution for discrete random variables, including computing the mean and standard deviation for the binomial variable.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A probability distribution is a complete listing of all possible outcomes of an experiment together with their probabilities. The procedure has a fixed number of independent trials. • A random variable assumes different values depending on the event outcome. • A probability distribution combines descriptive statistical techniques and probabilities to form a theoretical model of behavior.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Develop the binomial probability distribution within a real-world context. • Calculate the mean and standard deviation for the binomial variable. • Use the binomial distribution to calculate probabilities associated with experiments for which there are only two possible outcomes.

TOPIC: PROBABILITY

PROBABILITY AND STATISTICS
STANDARD PS.14

The student will simulate probability distributions, including binomial and geometric.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A probability distribution combines descriptive methods and probabilities to form a theoretical model of behavior. • A probability distribution gives the probability for each value of the random variable.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Design and conduct an experiment that simulates a binomial distribution. • Design and conduct an experiment that simulates a geometric distribution.

TOPIC: PROBABILITY

PROBABILITY AND STATISTICS
STANDARD PS.15

The student will identify random variables as independent or dependent and find the mean and standard deviations for sums and differences of independent random variables.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A random variable is a variable that has a single numerical value, determined by chance, for each outcome of a procedure.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare and contrast independent and dependent random variables. • Find the standard deviation for sums and differences of independent random variables.

TOPIC: PROBABILITY

PROBABILITY AND STATISTICS
STANDARD PS.16

The student will identify properties of a normal distribution and apply the normal distribution to determine probabilities, using a table or graphing calculator.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The normal distribution curve is a family of symmetrical curves defined by the mean and the standard deviation. • Areas under the curve represent probabilities associated with continuous distributions. • The normal curve is a probability distribution and the total area under the curve is 1.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the properties of a normal probability distribution. • Describe how the standard deviation and the mean affect the graph of the normal distribution. • Determine the probability of a given event, using the normal distribution.

TOPIC: INFERENTIAL STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.17

The student, given data from a large sample, will find and interpret point estimates and confidence intervals for parameters. The parameters will include proportion and mean, difference between two proportions, and difference between two means (independent and paired).

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• A primary goal of sampling is to estimate the value of a parameter based on a statistic. • Confidence intervals use the sample statistic to construct an interval of values that one can be reasonably certain contains the true (unknown) parameter. • Confidence intervals and tests of significance are complementary procedures. • Paired comparisons experimental design allows control for possible effects of extraneous variables.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Construct confidence intervals to estimate a population parameter, such as a proportion or the difference between two proportions; or a mean or the difference between two means. • Select a value for alpha (Type I error) for a confidence interval. • Interpret confidence intervals in the context of the data. • Explain the importance of random sampling for confidence intervals. • Calculate point estimates for parameters and discuss the limitations of point estimates.

TOPIC: INFERENTIAL STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.18

The student will apply and interpret the logic of a hypothesis-testing procedure. Tests will include large sample test for proportion, mean, difference between two proportions, and difference between two means (independent and paired) and Chi-squared tests for goodness of fit, homogeneity of proportions, and independence.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Confidence intervals and tests of significance are complementary procedures. • Paired comparisons experimental design allows control for possible effects of extraneous variables. • Tests of significance assess the extent to which sample data support a hypothesis about a population parameter. • The purpose of a goodness of fit test is to decide if the sample results are consistent with results that would have been obtained if a random sample had been selected from a population with a known distribution. • Practical significance and statistical significance are not necessarily congruent.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use the Chi-squared test for goodness of fit to decide if the population being analyzed fits a particular distribution pattern. • Use hypothesis-testing procedures to determine whether or not to reject the null hypothesis. The null hypothesis may address proportion, mean, difference between two proportions or two means, goodness of fit, homogeneity of proportions, and independence. • Compare and contrast Type I and Type II errors. • Explain how and why the hypothesis-testing procedure allows one to reach a statistical decision.

TOPIC: INFERENTIAL STATISTICS

PROBABILITY AND STATISTICS
STANDARD PS.19

The student will identify the meaning of sampling distribution with reference to random variable, sampling statistic, and parameter and explain the Central Limit Theorem. This will include sampling distribution of a sample proportion, a sample mean, a difference between two sample proportions, and a difference between two sample means.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The Central Limit Theorem states: – The mean of the sampling distribution of means is equal to the population mean. – If the sample size is sufficiently large, the sampling distribution approximates the normal probability distribution. – If the population is normally distributed, the sampling distribution is normal regardless of sample size. • Sampling distributions have less variability with larger sample sizes.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe the use of the Central Limit Theorem for drawing inferences about a population parameter based on a sample statistic. • Describe the effect of sample size on the sampling distribution and on related probabilities. • Use the normal approximation to calculate probabilities of sample statistics falling within a given interval. • Identify and describe the characteristics of a sampling distribution of a sample proportion, mean, difference between two sample proportions, or difference between two sample means.

TOPIC: INFERENTIAL STATISTICS

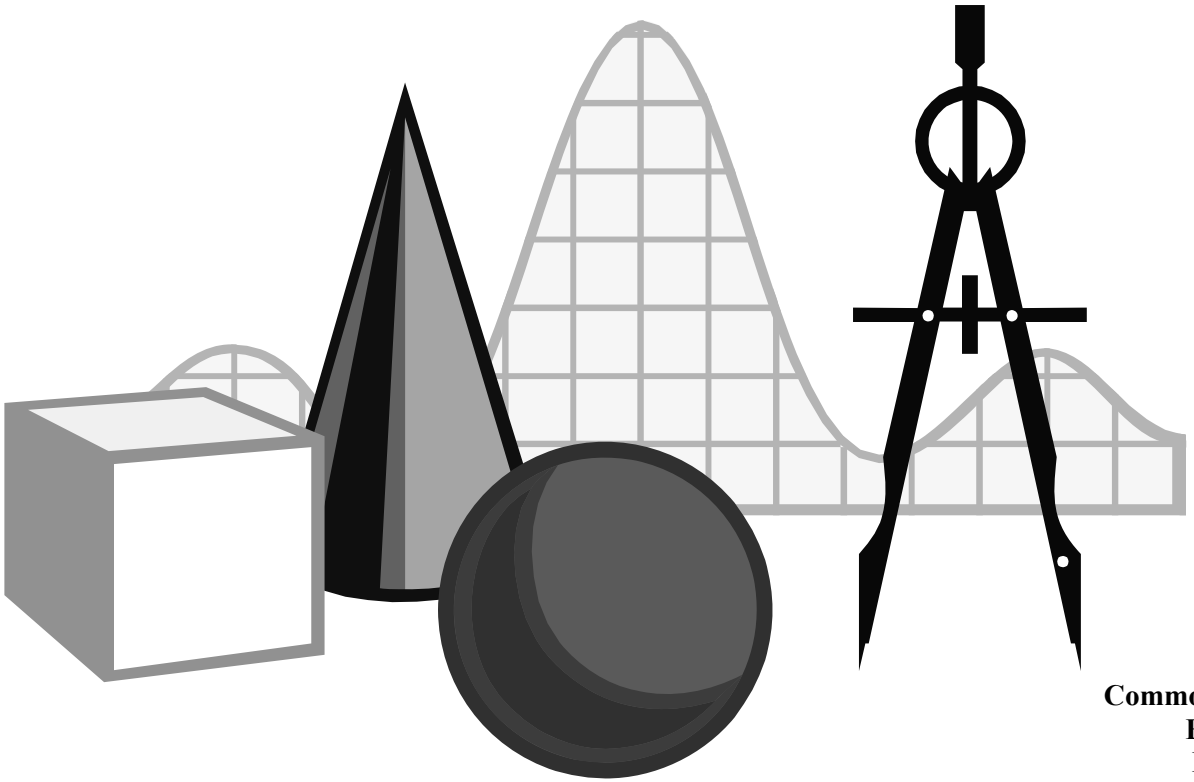
PROBABILITY AND STATISTICS
STANDARD PS.20

The student will identify properties of a t-distribution and apply t-distributions to single-sample and two-sample (independent and matched pairs) t-procedures, using tables or graphing calculators.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Paired comparisons experimental design allows control for possible effects of extraneous variables. • The sampling distribution of means with a small sample size follows a t-distribution.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify the properties of a t-distribution. • Compare and contrast a t-distribution and a normal distribution. • Use a t-test for single-sample and two-sample data.

MATHEMATICS STANDARDS OF LEARNING PROPOSED CURRICULUM FRAMEWORK

Mathematical Analysis



Commonwealth of Virginia
Board of Education
Richmond, Virginia
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TOPIC: FUNCTIONS

MATHEMATICAL ANALYSIS
STANDARD MA.1

The student will investigate and identify the characteristics of polynomial and rational functions and use these to sketch the graphs of the functions. This will include determining zeros, upper and lower bounds, *y*-intercepts, symmetry, asymptotes, intervals for which the function is increasing or decreasing, and maximum or minimum points. Graphing utilities will be used to investigate and verify these characteristics.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The graphs of polynomial and rational functions can be determined by exploring characteristics and components of the functions.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Identify a polynomial function, given an equation or graph. • Identify rational functions, given an equation or graph. • Identify domain, range, zeros, upper and lower bounds, *y*-intercepts, symmetry, asymptotes, intervals for which the function is increasing or decreasing, points of discontinuity, end behavior, and maximum and minimum points, given a graph of a function. • Sketch the graph of a polynomial function. • Sketch the graph of a rational function. • Investigate and verify characteristics of a polynomial or rational function, using a graphing calculator.

TOPIC: FUNCTIONS

MATHEMATICAL ANALYSIS
STANDARD MA.2

The student will apply compositions of functions and inverses of functions to real-world situations. Analytical methods and graphing utilities will be used to investigate and verify the domain and range of resulting functions.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• In composition of functions, a function serves as input for another function. • A graph of a function and its inverse are symmetric about the line $y = x$. • $\underline{(f \circ f^{-1})(x) = (f^{-1} \circ f)(x) = x}$	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Find the composition of functions. • Find the inverse of a function algebraically and graphically. • Determine the domain and range of the composite functions. • Determine the domain and range of the inverse of a function. • Verify the accuracy of sketches of functions, using a graphing utility.

TOPIC: FUNCTIONS

MATHEMATICAL ANALYSIS
STANDARD MA.3

The student will investigate and describe the continuity of functions, using graphs and algebraic methods.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Continuous and discontinuous functions can be identified by their equations or graphs.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Describe continuity of a function. • Investigate the continuity of absolute value, step, rational, and piece-wise-defined functions. • Use transformations to sketch absolute value, step, and rational functions. • Verify the accuracy of sketches of functions, using a graphing utility.

TOPIC: FUNCTIONS

MATHEMATICAL ANALYSIS
STANDARD MA.7

The student will find the limit of an algebraic function, if it exists, as the variable approaches either a finite number or infinity. A graphing utility will be used to verify intuitive reasoning, algebraic methods, and numerical substitution.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The limit of a function is the value approached by $f(x)$ as x approaches a given value or infinity.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Verify intuitive reasoning about the limit of a function, using a graphing utility. • Find the limit of a function algebraically, and verify with a graphing utility. • Find the limit of a function numerically, and verify with a graphing utility. • <u>Use limit notation when describing end behavior of a function.</u>

TOPIC: FUNCTIONS

MATHEMATICAL ANALYSIS
STANDARD MA.9

The student will investigate and identify the characteristics of exponential and logarithmic functions in order to graph these functions and solve equations and real-world problems. This will include the role of e, natural and common logarithms, laws of exponents and logarithms, and the solution of logarithmic and exponential equations.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS

• Exponential and logarithmic functions are inverse functions.
• Some examples of appropriate models or situations for exponential and logarithmic functions are:
  • Population growth;
  • Compound interest;
  • Depreciation/appreciation;
  • Richter scale; and
  • Radioactive decay.
	The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to
	• Identify exponential functions from an equation or a graph.
	• Identify logarithmic functions from an equation or a graph.
	• Define e, and know its approximate value.
	• Write logarithmic equations in exponential form and vice versa.
	• Identify common and natural logarithms.
	• Use laws of exponents and logarithms to solve equations and simplify expressions.
	• Model real-world problems, using exponential and logarithmic functions.
	• Graph exponential and logarithmic functions, using a graphing utility, and identify asymptotes, intercepts, domain, and range.

TOPIC: DISCRETE MATHEMATICS

MATHEMATICAL ANALYSIS
STANDARD MA.4

The student will expand binomials having positive integral exponents through the use of the Binomial Theorem, the formula for combinations, and Pascal's Triangle.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The Binomial Theorem provides a formula for calculating the product $(a + b)^n$ for any positive integer n. • Pascal's Triangle is a triangular array of binomial coefficients.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Expand binomials having positive integral exponents. • Use the Binomial Theorem, the formula for combinations, and Pascal's Triangle to expand binomials.

TOPIC: DISCRETE MATHEMATICS

MATHEMATICAL ANALYSIS
STANDARD MA.5

The student will find the sum (sigma notation included) of finite and infinite convergent series, which will lead to an intuitive approach to a limit.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Examination of infinite sequences and series may lead to a limiting process. • Arithmetic sequences have a common difference between any two consecutive terms. • Geometric sequences have a common factor between any two consecutive terms.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use and interpret the notation: $\sum$, n, nth, and a_n. • Given the formula, find the nth term, a_n, for an arithmetic or geometric sequence. • Given the formula, find the sum, S_n, if it exists, of an arithmetic or geometric series. • Model and solve problems, using sequence and series information. • Distinguish between a convergent and divergent series. • Discuss convergent series in relation to the concept of a limit.

TOPIC: DISCRETE MATHEMATICS

MATHEMATICAL ANALYSIS
STANDARD MA.6

The student will use mathematical induction to prove formulas and mathematical statements.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Mathematical induction is a method of proof that depends on a recursive process. • Mathematical induction allows reasoning from specific true values of the variable to general values of the variable.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Compare inductive and deductive reasoning. • Prove formulas/statements, using mathematical induction.

TOPIC: EQUATIONS

MATHEMATICAL ANALYSIS
STANDARD MA.10

The student will investigate and identify the characteristics of the graphs of polar equations, using graphing utilities. This will include classification of polar equations, the effects of changes in the parameters in polar equations, conversion of complex numbers from rectangular form to polar form and vice versa, and the intersection of the graphs of polar equations.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• The real number system is represented geometrically on the number line, and the complex number system is represented geometrically on the plane where $a + bi$ corresponds to the point (a, b) in the plane.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Recognize polar equations (rose, cardioid, limacon, lemniscate, spiral, and circle), given the graph or the equation. • Determine the effects of changes in the parameters of polar equations on the graph, using a graphing utility. • Convert complex numbers from rectangular form to polar form and vice versa. • Find the intersection of the graphs of two polar equations, using a graphing utility.

TOPIC: EQUATIONS

MATHEMATICAL ANALYSIS
STANDARD MA.12

The student will use parametric equations to model and solve application problems.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Parametric equations are used to express two dependent variables, x and y, in terms of an independent variable (parameter), t. • Some curves cannot be represented as a function, $f(x)$. Parametric graphing enables the representation of these curves in terms of functions.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Graph parametric equations, using a graphing utility. • Use parametric equations to model motion over time. • Determine solutions to parametric equations, using a graphing utility. • Compare and contrast traditional solution methods with parametric methods.

TOPIC: EQUATIONS

MATHEMATICAL ANALYSIS
STANDARD MA.14

The student will use matrices to organize data and will add and subtract matrices, multiply matrices, multiply matrices by a scalar, and use matrices to solve systems of equations.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Matrices are a convenient shorthand for solving systems of equations. • Matrices can model a variety of linear systems. • Solutions of a linear system are values that satisfy every equation in the system. • Matrices can be used to model and solve real-world problems.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Add, subtract, and multiply matrices and multiply matrices by a scalar. • Model problems with a system of no more than three linear equations. • Express a system of linear equations as a matrix equation. • Solve a matrix equation. • Find the inverse of a matrix. • <u>Verify the commutative and associative properties for matrix addition and multiplication.</u>

TOPIC: ANALYTICAL GEOMETRY

MATHEMATICAL ANALYSIS
STANDARD MA.8

The student will investigate and identify the characteristics of conic section equations in (*h, k*) and standard forms. Transformations in the coordinate plane will be used to graph conic sections.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Matrices can be used to represent transformations of figures in the plane.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Given a translation or rotation matrix, find an equation for the transformed function or conic section. • Investigate and verify graphs of transformed conic sections, using a graphing utility.

TOPIC: ANALYTICAL GEOMETRY

MATHEMATICAL ANALYSIS
STANDARD MA.11

The student will perform operations with vectors in the coordinate plane and solve real-world problems using vectors. This will include the following topics: operations of addition, subtraction, scalar multiplication, and inner (dot) product; norm of a vector; unit vector; graphing; properties; simple proofs; complex numbers (as vectors); and perpendicular components.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• Every vector has an equal vector that has its initial point at the origin. • The magnitude and direction of a vector with the origin as the initial point are completely determined by the coordinates of its terminal point.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Use vector notation. • Perform the operations of addition, subtraction, scalar multiplication, and inner (dot) product on vectors. • Graph vectors and resultant vectors. • Express complex numbers in vector notation. • Define *unit vector*, and find the unit vector in the same direction as a given vector. • Identify properties of vector addition, scalar multiplication, and dot product. • Find vector components. • Find the norm (magnitude) of a vector. • Use vectors in simple geometric proofs.

TOPIC: ANALYTICAL GEOMETRY

MATHEMATICAL ANALYSIS
STANDARD MA.11

The student will perform operations with vectors in the coordinate plane and solve real-world problems using vectors. This will include the following topics: operations of addition, subtraction, scalar multiplication, and inner (dot) product; norm of a vector; unit vector; graphing; properties; simple proofs; complex numbers (as vectors); and perpendicular components.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
	• Solve real-world problems using vectors.

TOPIC: ANALYTIC GEOMETRY

MATHEMATICAL ANALYSIS
STANDARD MA.13

The student will identify, create, and solve real-world problems involving triangles. Techniques will include using the trigonometric functions, the Pythagorean Theorem, the Law of Sines, and the Law of Cosines.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
• ~~Real-life~~ Real-world problems can be modeled using trigonometry and vectors.	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to** • Solve and create problems, using trigonometric functions. • Solve and create problems, using the Pythagorean Theorem. • Solve and create problems, using the Law of Sines and the Law of Cosines. • Solve real-world problems using vectors.

Board of Education Agenda Item

Item: I. **Date:** October 22, 2009

Topic: First Review of Proposed Revised *English Standards of Learning*

Presenter: Ms. Tracy Fair Robertson, English Coordinator

Telephone Number: (804) 371-7585 **E-Mail Address:** Tracy.Robertson@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

____ Action requested at this meeting _X_ Action requested at future meeting: After public comment

Previous Review/Action:

____ No previous board review/action

_X_ Previous review/action
Date January 15, 2009
Action Board of Education approved the timeline to proceed with the review process.

Background Information:
The Standards of Learning for English were developed in 1995 and revised in 2002. The *Standards of Quality* require the Board of Education to review the Standards of Learning on a regular schedule. The *English Standards of Learning* are scheduled for review in 2010. As a result, on January 15, 2009, the Board approved a plan to review these standards. In accordance with the plan, the Department of Education took the following steps to produce a draft of the proposed revised *English Standards of Learning* for the Board's first review:

- Received online comments from stakeholders, including teachers, parents, and administrators that are summarized in Attachment A;
- Met with a teacher review committee that consisted of recommended individuals solicited from school divisions on July 14 and 15, 2009, to review the public comment and consider recommendations and reports from Achieve, The College Board, ACT, as well as the National Association of Teachers of English (NCTE), The International Reading Association (IRA) Standards, The American Association of School Librarians (AASL) Standards for the 21st Century Learner, and NCTE 21st Century Skills Map;
- Solicited a postsecondary review committee comprised of English and English education faculty and met with the review committee on August 5, 2009;
- Solicited business leaders' comments; and
- Developed a draft of the proposed revised *English Standards of Learning*.

Summary of Major Elements:
The attached draft of the proposed revised *English Standards of Learning* (Attachment B) consists of the following elements:

Introduction
The *English Standards of Learning* identify academic content for essential components of the English curriculum at different grade levels for Virginia's public schools. Standards are identified for kindergarten through grade twelve. Throughout a student's academic career from kindergarten through grade twelve, specific content strands are included. The Standards of Learning for each strand progress in complexity at each grade level.

Organization
The goals of the *English Standards of Learning* are to teach students to read and to prepare students to participate in society as literate citizens, equipped with the ability to communicate effectively in their communities, in the workplace, and in postsecondary education. As students progress through the school years, they become active and involved listeners and develop a full command of the English language, evidenced by their use of standard English and their rich speaking and writing vocabularies. Standards for kindergarten through third grade are organized in three related strands: Oral Language, Reading, and Writing. Standards for fourth through twelfth grades are organized in four related strands: Communication: Listening, Speaking, and Media Literacy; Reading; Writing; and Research. Each grade level is preceded by an overview that describes the major concepts and skills that each student will be expected to understand and demonstrate. The standards reflect a comprehensive instructional program and document a progression of expected achievement in each of the strands. This organization of standards also reflects the gradual progression in the development of skills.

Standards
The *English Standards of Learning* for Virginia public schools describe the Commonwealth's expectations for student learning and achievement in grades K-12. The standards are not intended to encompass the entire curriculum for a given grade level or course or to prescribe how the content should be taught. Teachers are encouraged to go beyond the standards and select instructional strategies and assessment methods appropriate for their students.

Summary of the Proposed Revised *English Standards of Learning*
The major elements of the attached proposed revised *English Standards of Learning* include:

- Edits to enhance clarity, specificity, rigor, alignment of skills and content, and a reflection of the current academic research and practice;
- Emphasis on vertical alignment in grades 4-12;
- Addition of the media literacy content in the communication strand;
- Addition of the research strand beginning in grade four;
- Addition of the specific vocabulary standards in high school; and
- Addition of 21st Century Skills.

Superintendent's Recommendation:
The Superintendent of Public Instruction recommends that the Board of Education accept for first review the proposed revised *English Standards of Learning*.

Impact on Resources:
This responsibility can be absorbed by the agency's existing resources at this time. If the agency is required to absorb additional responsibilities related to this activity, other services may be impacted.

Timetable for Further Review/Action:
The *English Standards of Learning* review work plan calls for public hearings, final review, and adoption of the *English Standards of Learning* by the Board of Education by January 2010.

Summary of Online Comments
K-12 *English Standards of Learning*
January 23, 2009-February 23, 2009

During the public comment period, 27 comments were received electronically for the *English Standards of Learning K-12*. No comments were received via U.S. mail.

The number of comments received is listed by grade span below:

Grade Span	Number of Comments
K-5	12
6-8	10
9-12	4
General	1

General comments included for elementary grades (K-5) *English Standards of Learning* were:

- Make all kindergarten skills measureable;
- Specify ten high frequency words for kindergarten;
- Move long vowel sounds from grade 2 to grade 1;
- Teach syllable "le" in grade 2;
- Expand vocabulary standards for grade 2;
- Move some of the grade 3 content to other grades;
- Clarify 3.5j fable;
- Introduce other syllable types before introducing Consonant-Vowel-Vowel- Consonant (CVVC);
- Add specificity to elementary grammar skills;
- Add consistency to terminology and building on skills from grade to grade; and
- Make the elementary grammar standards more specific.

General comments included for the middle grades (6-8) *English Standards of Learning* were:

- Remove analogies; they are no longer on the SAT;
- Remove sentence diagramming;
- Include research and documentation of sources;
- Move the poetic devices of assonance and consonance to high school;
- Put drawing inferences and reaching conclusions in the same standard;
- Delete all oral language standards;
- Include more basic reading strategies in middle school; and
- Provide a list of affixes and root words.

General comments included for the high school courses (9-12) *English Standards of Learning* were:

- Combine standards 9.1 with 9.2;
- Update 9.4 and 10.4 to use current technology;
- Provide vocabulary standards; and
- Provide more opportunities for all students to write poetry.

Additional comments addressed the SOL assessments.

Proposed Revised English Standards of Learning

for Virginia Public Schools

First Review

October 22, 2009

Introduction

The goals of the English Standards of Learning are to teach students to read, write, and communicate. ~~and to prepare students~~. They should be prepared to participate in society as literate citizens, equipped with the ability to communicate effectively in their communities, in the workplace, and in postsecondary education. As students progress through the school years, they become active and involved listeners and develop a full command of the English language, evidenced by their use of standard English and their rich speaking and writing vocabularies.

Students become competent readers of a variety of ~~print materials~~ texts and are encouraged to acquire a lifelong love of reading. In kindergarten through third grade, the primary goal is to teach all students to read fluently and to comprehend a variety of fiction and nonfiction selections that relate to all areas of the curriculum. In fourth through twelfth grades, students continue to acquire and refine strategies for comprehending and analyzing selections that encompass all literary ~~types~~ genres, exemplify universal themes, and relate to all subjects. Students in high school become familiar with ~~exemplary~~ a wide variety of authors and classic literary works.

Proficient use of the English language enables students to explore and articulate the complex issues and ideas encountered in public and personal life. Students acquire the ability to make full and effective use of the written language in their future educational, occupational, and personal endeavors.

Organization of the English Standards of Learning

Standards for kindergarten through ~~eighth~~ third grade are organized in three related strands: Oral Language, Reading, and Writing. Standards for ~~ninth~~ fourth through twelfth grades are organized in four related strands: ~~Oral Language~~ Communication: Speaking, Listening, and Media Literacy; Reading ~~Analysis~~; Writing; and Research. Each grade level is preceded by an overview that describes the major concepts and skills that each student will be expected to understand and demonstrate. The standards reflect a comprehensive instructional program and document a progression of expected achievement in each of the strands. This organization of standards also reflects the gradual progression in the development of skills.

Oral Language includes speaking and listening in kindergarten through third grade. In the early grades, students learn to participate in classroom discussion. ~~Over the course of several grade levels,~~ In grades three through twelve, students learn to prepare, ~~and~~ deliver, and critique oral presentations ~~and to critique them in order to improve delivery~~. In grades four through twelve the Oral Language strand changes to become Communication: Speaking, Listening, and Media Literacy. Students will analyze, develop and produce media messages. However, students' home and cultural languages are the starting point for all language learning; competency in the use of standard English is the goal for all students. ~~Over the course of several grade levels, students learn to prepare, and deliver, and to critique them in order to improve delivery. Students' homes and cultural languages are the starting point for all language learning; however, competency in the use of standard English is the goal for all students.~~ Therefore, daily speaking opportunities, both formal and informal, should be a part of every English curriculum.

Reading begins with an awareness of the concepts of print and the sounds and structure of oral and written language. Students in the primary grades acquire a strong foundation in phonological and phonemic awareness, phonics, vocabulary, fluency, and comprehension strategies. Students continue to study the structure of words and language and refine comprehension strategies throughout all grades. In the middle school and high school grades, students ~~focus on the analysis~~ analyze ~~of~~ what they read and

~~the application of what they learn and~~ apply that learning. Both reading in other content areas and reading of nonfictional texts are essential for all students. ~~Daily oral language and reading experiences are essential for all students~~. Students' appreciation for ~~literature~~ literary texts is enhanced by frequent interaction with a broad array of classic and contemporary literature, which engages the reading skills of students and invites them to develop an appreciation for the power and beauty of the written word. The combination of teachers reading aloud and students selecting reading materials is necessary in helping students develop a lifelong reading habit and an appreciation for literature.

Writing begins with letter formation and the use of letters to represent speech sounds. From kindergarten through twelfth grade, students become increasingly aware of the structure of language and the writing process. Improvement in written communication is achieved through frequent opportunities to apply narrative, ~~persuasive,~~ expository, and persuasive/argumentative ~~technical~~ skills. Daily ~~reading,~~ writing~~, and oral language~~ experiences are essential for all students. ~~The combination of teachers reading aloud and of students selecting reading materials is necessary in helping students develop a lifelong reading habit and an appreciation for literature.~~

Research standards are also developed across grade levels. ~~In grades nine through twelve, research is a separate strand.~~ In kindergarten through ~~eighth~~ third grade, research skills are incorporated in the reading and writing strands. In grades ~~nine~~ four through twelve, research is a separate strand where students learn to access information, evaluate the validity of sources, document those sources, and synthesize that information into a research-based product. ~~Through these standards, students learn to acquire information from a variety of sources to use in planning and delivering presentations and reports.~~

~~Student learning is enhanced through the use of computer technology~~. Technology enhances student learning ~~Data access, retrieval,~~ and ~~processing~~ supports instruction in reading, writing, and research. ~~In composition, word processing programs allow students to check spelling, grammar, and style to revise drafts.~~ In the writing process, technology enables students to compose, revise, edit, share, and publish their writing. Information technology is an integral part of student ~~research~~ learning, ~~and helps~~ assisting students to produce effective written and oral ~~presentations~~ communication. ~~However, the use of computer-aided spelling and grammar is not a substitute for learning the rules of English.~~

Although the strands are developed separately, they are integrated in the classroom. Proficiency in reading, writing, listening, speaking, media literacy and research skills allows students to learn and to use knowledge to make meaningful connections between their lives and academic disciplines. There should be a concerted effort to relate required reading selections in English to studies in other core subjects, including mathematics, science, and history and social science. Standards that incorporate rigor in English help students develop the expected performance competencies.

Kindergarten

The kindergarten student will be immersed in a print-rich environment to develop oral language skills, phonological awareness, print awareness, vocabulary, comprehension, and an appreciation for literature. The reading of fiction and nonfiction ~~selections~~ texts will enable students to develop an awareness of print materials as sources of information and enjoyment. The kindergarten student will have the opportunity to use words that describe people, places, and events. The student will recognize and print letters of the alphabet, use the basic phonetic principles of identifying and writing beginning sounds, identify story elements, and communicate ideas through pictures and writing.

Oral Language

K.1 The student will demonstrate growth in the use of oral language.

a) Listen to a variety of literary forms, including stories and poems.
b) Participate in a variety of oral language activities including choral and echo speaking and ~~recite~~ recitation of short poems, rhymes, songs, and stories with repeated word order patterns.
c) Participate in oral generation of language experience narratives. ~~Participate in creative dramatics~~. [Moved to SOL K.1d]
d) Participate in creative dramatics. ~~Begin to discriminate between spoken sentences, words, and syllables.~~ [Moved to SOL K.4a]
e) Use complete sentences that include subject, verb, and object. ~~Recognize rhyming words.~~ [Moved to SOL K.4b]
~~f) Generate rhyming words in a rhyming pattern.~~ [Moved to SOL K.4b]

K.2 The student will ~~use listening and speaking vocabularies.~~ expand understanding and use of word meanings.

a) Increase listening and speaking vocabularies. ~~Use number words.~~ [Moved to SOL K.2b]
b) Use number words. ~~Use words to describe/name people, places, and things.~~ [Moved to SOL K.2c]
c) Use words to describe/name people, places, and things. ~~Use words to describe location, size, color, and shape.~~ [Moved to SOL K.2d]
d) Use words to describe/name location, size, color, and shape. ~~Use words to describe actions.~~ [Moved to SOL K.2e]
e) Use words to describe/name actions. ~~Ask about words not understood.~~ [Moved to SOL K.2f]
f) Ask about words not understood. ~~Follow one-step and two-step directions.~~ [Moved to SOL K.3g]
g) Use vocabulary from other content areas. ~~Begin to ask how and why questions.~~ [Moved to SOL K.3h]

K.3 The student will build oral communication skills.

a) Express ideas in complete sentences and express needs through direct requests. ~~Begin to follow implicit rules for conversation, including taking turns and staying on topic.~~ [Moved to SOL K.3c]
b) Begin to initiate conversations. ~~Express ideas and needs in complete sentences.~~ [Moved to SOL K.3a]
c) Begin to follow implicit rules for conversation, including taking turns and staying on topic.
d) Listen and speak in informal conversations with peers and adults. ~~Begin to use voice level, phrasing, and intonation appropriate for language situation.~~ [Moved to SOL K.3f]
e) Participate in group and partner discussions about various texts and topics. ~~Begin to initiate conversations.~~ [Moved to SOL K.3b]
f) Begin to use voice level, phrasing, and intonation appropriate for various language situations. ~~Participate in discussions about books and specific topics.~~ [Moved SOL to K.3e]
g) Follow one-~~step~~ and two-step directions.
h) Begin to ask how and why questions.

K.4 The student will ~~hear~~ identify, say, ~~and manipulate phonemes (small units of sound) of spoken language~~, segment, and blend various units of speech sounds.

a) Begin to discriminate between spoken sentences, words, and syllables. ~~Identify orally words that rhyme.~~ [Moved to SOL K.4b]
b) Identify and produce words that rhyme. ~~Identify words orally according to shared beginning or ending sounds.~~ [Moved to SOL K.4e]
c) Blend and segment multisyllabic words at the syllable level.
d) ~~Divide~~ Segment one-syllable words into speech sound~~s~~ units ~~(phonemes)~~ including beginning phoneme(s) (onset) and ending (rimes).
e) ~~Divide words into syllables~~ Identify words ~~orally~~ according to shared beginning and/or ending sounds.

Reading

K.5 The student will understand how print is organized and read.

a) Hold print materials in the correct position.
b) Identify the front cover, back cover, and title page of a book.
c) Distinguish between print and pictures. ~~Follow words from left to right and from top to bottom on a printed page.~~ [Moved to SOL K.5d]
d) Follow words from left to right and from top to bottom on a printed page. ~~Match voice with print: syllables, words, and phrases.~~ [Moved to SOL K.5e]
e) Match voice with print~~: syllables, words, and phrases~~ (concept of word).

K.6 The student will demonstrate an understanding that print ~~makes sense~~ conveys meaning.

a) Identify common signs and logos. ~~Explain that printed materials provide information.~~ [Moved to SOL K.6b]
b) Explain that printed materials provide information. ~~Identify common signs and logos.~~ [Moved to SOL K.6a]
c) Read and explain own writing and drawings. ~~Read ten high-frequency words.~~ [Moved to SOL K.6d]
d) Read his/her name and read fifteen meaningful, concrete words. ~~Read and explain own writing and drawings.~~ [Moved to SOL K.6c]

K.7 The student will develop an understanding of basic phonetic principles.

a) Identify and name the uppercase and lowercase letters of the alphabet.
b) Match consonant, ~~and~~ short vowel, and initial consonant diagraph sounds to appropriate letters.
c) Demonstrate a speech-to-print match through accurate finger-point reading in familiar text that includes words with more than one syllable. ~~Identify beginning consonant sounds in single-syllable words.~~ [Moved to SOL K.7d]
d) Identify beginning consonant sounds in single-syllable words.

K.8 The student will expand vocabulary.

a) Discuss meanings of words.
b) Develop vocabulary by listening to a variety of texts read aloud.

~~K.8~~ K.9 The student will demonstrate comprehension of fictional texts ~~and nonfiction~~.

a) Identify what an author does and what an illustrator does. ~~Use pictures to make predictions about content.~~ [Moved to SOL K.9c]
b) Relate previous experiences to what is read. ~~Retell familiar stories, using beginning, middle, and end.~~ [Moved to SOL K.9f]
c) Use pictures to make predictions. ~~Discuss characters, setting, and events.~~ [Moved to SOL K.9g]
d) Begin to ask and answer questions about what is read. ~~Use story language in discussions and retellings.~~ [Moved to SOL K.9e]
e) Use story language in discussions and retellings. ~~Identify what an author does and what an illustrator does.~~ [Moved to SOL K.9a]
f) Retell familiar stories, using beginning, middle, and end. ~~Identify the topics of nonfiction selections.~~
g) Discuss characters, setting, and events.

K.10 The student will demonstrate comprehension of nonfictional texts.

a) Use pictures to identify topic and make predictions.
b) Identify text features specific to the topic, such as titles, headings, and pictures.

Writing

~~K.9~~ K.11 The student will print in manuscript ~~the uppercase and lowercase letters of the alphabet independently~~.[Moved to SOL K.11a]

a) Print ~~the~~ uppercase and lowercase letters of the alphabet independently.
b) ~~The student will p~~Print his/her first and last names.

~~K.10~~ ~~The student will print his/her first and last names.~~ [Moved to SOL K.11b)

~~K.11~~ K.12 The student will write to communicate ideas for a variety of purposes.

a) Differentiate pictures from writing. ~~Draw pictures and/or use letters and phonetically spelled words to write about experiences, stories, people, objects, or events.~~ [Moved to SOL K.12b]

b) Draw pictures and/or use letters and phonetically spelled words to write about experiences. ~~Write left to right and top to bottom.~~ [Moved to SOL K.12d]

c) Use letters and beginning consonant sounds to phonetically spell words to describe pictures or write about experiences.

d) Write left to right and top to bottom.

~~K.12~~ K.13 The student will use available technology for reading and writing.

Grade One

Reading is the priority in first grade. The student will be immersed in a print-rich environment to develop oral language skills, phonetic skills, vocabulary, comprehension, and an awareness of print materials as sources of information and enjoyment. The student will use listening and speaking skills to participate in classroom discussions. The student will use a variety of strategies to read new words and will read familiar selections with fluency and expression. The student will continue to develop an understanding of character, setting, main idea, and story sequence in a variety of texts. The student will increase vocabulary and comprehension strategies by reading ~~age-appropriate materials~~ across the curriculum, with emphasis on materials that reflect the Standards of Learning in mathematics, science, and history and social science. The student will also demonstrate comprehension of fiction and nonfiction ~~selections~~ texts through classroom discussion and will begin to communicate ideas in writing. ~~The student will become an independent reader by the end of first grade.~~

Oral Language

1.1 The student will continue to demonstrate growth in the use of oral language.

a) Listen and respond to a variety of electronic media~~, including books, audiotapes, videos,~~ and other age-appropriate materials.
b) Tell and retell stories and events in logical order.
c) Participate in a variety of oral language activities, including choral speaking and reciting short poems, rhymes, songs, and stories with repeated patterns.
d) Participate in creative dramatics. ~~Express ideas orally in complete sentences.~~ [Moved to SOL 1.1e]
e) Express ideas orally in complete sentences.

1.2 The student will ~~continue to~~ expand ~~and use listening and speaking vocabularies~~ understanding and use of word meanings.

a) Increase ~~oral descriptive vocabulary~~ listening and speaking vocabularies.
b) Begin to ask for clarification and explanation of words and ideas.
c) Use common singular and plural nouns. ~~Follow simple two-step oral directions.~~ [Moved to SOL 1.3d]
d) Use vocabulary from other content areas. ~~Give simple two-step oral directions.~~ [Moved to SOL 1.3e]
~~e) Use singular and plural nouns.~~ [Moved to SOL 1.2c]

1.3 The student will adapt or change oral language to fit the situation.

a) Initiate conversation with peers and adults.
b) Follow rules for conversation using appropriate voice level in small-group settings.
c) Ask and respond to questions. ~~Use appropriate voice level in small-group settings.~~ [Moved to SOL 1.3 b]
d) Follow simple two-step oral directions. ~~Ask and respond to questions in small-group settings.~~ [Moved to SOL 1.3c]
e) Give simple two-step oral directions.

1.4 The student will orally identify, produce, and manipulate ~~phonemes (small units of sound) in syllables and multisyllabic words~~ various units of speech sounds within words.

a) Create rhyming words. ~~Count phonemes (sounds) in syllables or words with a maximum of three syllables.~~ [Moved to SOL 1.4b]
b) Count phonemes (sounds) in one-syllable words. ~~Add or delete phonemes (sounds) orally to change syllables or words.~~ [Moved to SOL 1.4e]
c) Blend sounds to make one-syllable words. ~~Create rhyming words orally.~~ [Moved to SOL l.4a]
d) Segment one syllable words into individual speech sounds (phonemes). ~~Blend sounds to make word parts and words with one to three syllables.~~ [Moved to SOL 1.4c]
e) Add or delete phonemes (sounds) ~~orally~~ to ~~change~~ make new ~~syllables or~~ words.

Reading

1.5 The student will apply knowledge of how print is organized and read.

a) Read from left to right and from top to bottom.
b) Match spoken words with print.
c) Identify letters, words, ~~and~~ sentences, and ending punctuation.
d) Read his/her own writing.

1.6 The student will apply phonetic principles to read and spell.

a) Use beginning and ending consonants to decode and spell single-syllable words.
b) Use two-letter consonant blends to decode and spell single-syllable words.
c) Use beginning consonant digraphs to decode and spell single-syllable words.
d) Use short vowel sounds to decode and spell single-syllable words.
e) Blend beginning, middle, and ending sounds to recognize and read words.
f) Use word patterns to decode unfamiliar words.
g) ~~Use~~ Read and spell simple two-syllable compound words.
h) Read and spell commonly used~~,~~ ~~high-frequency~~ sight words~~, including *the*, *said*, and *come*~~.

1.7 The student will use ~~meaning~~ semantic clues and ~~language structure~~ syntax to expand vocabulary when reading.

a) Use words, phrases, and sentences. ~~Use titles and pictures.~~ [Moved to SOL 1.7b]
b) Use titles and pictures. ~~Use knowledge of the story and topic to read words.~~ [Moved to SOL 1.7c]
c) Use information in the story to read words. ~~Use knowledge of sentence structure.~~ [Moved to SOL 1.7d]
d) Use knowledge of sentence structure. ~~Reread and self-correct.~~ [Moved to SOL l.7f]
e) Use knowledge of story structure.
f) Reread and self-correct.

1.8 The student will expand vocabulary.

a) Discuss meanings of words in context.
b) Develop vocabulary by listening to and reading a variety of texts.
c) Ask for the meaning of unknown words and make connections to familiar words.
d) Use text clues such as words or pictures to discern meanings of unknown words.
e) Use vocabulary from other content areas.

~~1.8~~ 1.9 The student will read and re-read familiar stories, poems, and passages with fluency, accuracy, and meaningful expression.

~~1.9~~ 1.10 The student will read and demonstrate comprehension of a variety of fictional texts. ~~and nonfiction.~~

a) Preview the selection.
b) Set a purpose for reading.
c) Relate previous experiences to what is read.
d) Make and confirm predictions ~~about content~~.
e) Ask and answer who, what, when, where, why, and how questions about what is read.
f) Identify characters, setting, and important events.
g) Retell stories and events, using beginning, middle, and end.
h) Identify the ~~topic or~~ main idea or theme.

1.11 The student will read and demonstrate comprehension of a variety of nonfictional texts.

a) Preview the selection.
b) Use prior and background knowledge as context for new learning.
c) Set a purpose for reading.
d) Identify text features such as pictures, headings, charts, and captions.
e) Make and confirm predictions.
f) Ask and answer who, what, where, when, why, and how questions about what is read.
g) Identify the main idea.

~~1.10~~ 1.12 The student will use simple reference materials.

a) Use knowledge of alphabetical order by first letter.
b) Use a picture dictionary to find meanings of unfamiliar words.

Writing

~~1.11~~ 1.13 The student will print legibly.

a) Form letters accurately.
b) Space words ~~and~~ within sentences.
c) Use the alphabetic code to write unknown words phonetically.

~~1.12~~ 1.14 The student will write to communicate ideas for a variety of purposes.

a) Generate ideas.
b) Focus on one topic.
c) ~~Use~~ Revise by adding descriptive words when writing about people, places, things, and events.
d) Use complete sentences in final copies.
e) Begin each sentence with a capital letter and use ending punctuation in final copies.
f) Use correct spelling for ~~high-frequency~~ commonly used sight words and phonetically regular words in final copies.
g) Share writing with others.
~~h) Use available technology.~~ [Moved to SOL 1.15]

1.15 The student will use available technology for reading and writing.

Grade Two

Reading continues to be a priority in second grade. The student will be immersed in an ~~print-rich~~ environment filled with fiction and nonfiction ~~selections~~ texts, which relate to all areas of the curriculum and interest. The student will expand vocabulary by speaking and listening effectively in classroom discussions, use a combination of strategies when reading, and read ~~age-appropriate~~ familiar selections with fluency and expression. The student will learn comprehension strategies for fiction and nonfiction ~~materials~~ texts. The student will be asked to identify main ideas, to make and confirm predictions, and to formulate questions about learning in all subjects, with emphasis on materials that reflect the Standards of Learning in mathematics, science, and history and social science. The student will write stories, letters, and simple explanations; apply simple grammatical principles to writing; and locate information in reference materials.

Oral Language

2.1 The student will demonstrate an understanding of oral language structure.

a) Create oral stories to share with others.
b) Create and participate in oral dramatic activities.
c) Use correct verb tenses in oral communication.
d) Use increasingly complex sentence structures in oral communication.
e) Begin to self-correct errors in language use.

2.2 The student will ~~continue to~~ expand understanding and use of word meanings ~~listening and speaking vocabularies~~.

a) Increase listening and speaking vocabularies. ~~Use words that reflect a growing range of interests and knowledge.~~ [Moved to SOL 2.2b]
b) Use words that reflect a growing range of interests and knowledge. ~~Clarify and explain words and ideas orally.~~ [Moved to SOL 2.2c]
c) Clarify and explain words and ideas orally. ~~Follow oral directions with three or four steps.~~ [Moved to SOL 2.3e]
d) Identify and use synonyms and antonyms. ~~Give three-step and four-step directions.~~ [Moved SOL to 2.3f]
e) Use vocabulary from other content areas. ~~Identify and use synonyms and antonyms in oral communication.~~ [Moved to SOL 2.2d]

2.3 The student will use oral communication skills.

a) Use oral language for different purposes: to inform, to persuade, ~~and~~ to entertain, to clarify, and to respond.
b) Share stories or information orally with an audience.
c) Participate as a contributor and leader in a group.
d) ~~Summarize~~ Retell information shared ~~orally~~ by others.
e) Follow three- and four-step directions.
f) Give three-~~step~~ and four-step directions.

Reading

~~2.4~~ ~~The student will use phonetic strategies when reading and spelling.~~ [Moved to SOL 2.5]

~~a)~~ ~~Use knowledge of consonants, consonant blends, and consonant digraphs to decode and spell words.~~ [Moved to SOL 2.5]

~~b)~~ ~~Use knowledge of short, long, and r-controlled vowel patterns to decode and spell words.~~ [Moved to SOL 2.5]

~~c)~~ ~~Decode regular multisyllabic words.~~ [Moved to SOL 2.5]

2.4 The student will orally identify, produce, and manipulate various units of speech sounds within words.

a) Count phonemes (sounds) within one-syllable words.
b) Blend sounds to make one-syllable words.
c) Segment one-syllable words into individual speech sounds (phonemes).
d) Add or delete phonemes (sounds) to make words.
e) Blend and segment multisyllabic words at the syllable level.

~~2.4~~ 2.5 The student will use phonetic strategies when reading and spelling.

a) Use knowledge of consonants, consonant blends, and consonant digraphs to decode and spell words.
b) Use knowledge of short, long, and r-controlled vowel patterns to decode and spell words.
c) Decode regular multisyllabic words.

~~2.5~~ 2.6 The student will use ~~meaning~~ semantic clues and ~~language structure~~ syntax to expand vocabulary when reading.

a) Use information in the story to read words.
b) Use knowledge of sentence structure.
c) Use knowledge of story structure and sequence.
d) Reread and self-correct.

~~2.6~~ 2.7 The student will ~~use language structure to~~ expand vocabulary when reading.

a) Use knowledge of homophones. ~~Use knowledge of prefixes and suffixes.~~ [Moved to SOL 2.7b]
b) Use knowledge of prefixes and suffixes. ~~Use knowledge of contractions and singular possessives.~~ [Moved to SOL 2.14f]
c) Use knowledge of antonyms and synonyms. ~~Use knowledge of simple abbreviations.~~ [Moved to SOL 2.14g]
d) Discuss meanings of words and develop vocabulary by listening and reading a variety of texts. ~~Use knowledge of antonyms and synonyms.~~ [Moved to SOL 2.7c]
e) Use vocabulary from other content areas.

~~2.7~~ ~~The student will read fiction and nonfiction, using a variety of strategies independently.~~ [Moved to SOL 2.9 and SOL 2.10]

~~a)~~ ~~Preview the selection by using pictures, diagrams, titles, and headings.~~

~~b)~~ ~~Set purpose for reading.~~

~~c)~~ ~~Read stories, poems, and passages with fluency and expression.~~

~~d)~~ ~~Reread and self-correct when necessary.~~ [Moved to SOL 2.6]

2.8 The student will read and re-read familiar stories, poems, and passages with fluency, accuracy, and meaningful expression.

~~2.8~~ 2.9 The student will read and demonstrate comprehension of fictional texts ~~and nonfiction~~.

a) Make and confirm predictions ~~about content~~.
b) Relate previous experiences to the main idea. ~~Read to confirm predictions.~~ [Moved to SOL 2.9a]
c) Ask and answer questions about what is read. ~~Relate previous experiences to the topic.~~ [Moved to SOL 2.9b]
d) Locate information to answer questions. ~~Ask and answer questions about what is read.~~ [Moved to SOL 2.9c]
e) Describe characters, setting, and important events in fiction and poetry. ~~Locate information to answer questions.~~ [Moved to SOL 2.9d]
f) Identify the problem and solution. ~~Describe characters, setting, and important events in fiction and poetry.~~ [Moved to SOL 2.9e]
g) Identify the ~~problem, solution, and~~ main idea.
h) Summarize stories and events with beginning, middle, and end in the correct sequence. ~~Identify the problem, solution, and main idea.~~ [Moved to SOL 2.9f and SOL 2.9g]]
i) Draw conclusions based on the text.

2.10 The student will read and demonstrate comprehension of nonfictional texts.

a) Preview the selection using text features.
b) Make and confirm predictions about the main idea.
c) Use prior and background knowledge as context for new learning.
d) Set purpose for reading.
e) Ask and answer questions about what is read.
f) Locate information to answer questions.
g) Identify the main idea.

~~2.9~~ 2.11 The student will demonstrate comprehension of information in reference materials.

a) Use table of contents.
b) Use pictures, captions, and charts.
c) Use dictionaries, glossaries, and indices.
d) Use online resources.

Writing

~~2.10~~ 2.12 The student will maintain legible ~~manuscript~~ printing and begin to make the transition to cursive.

~~2.11~~ 2.13 The student will write stories, letters, and simple explanations.

a) Generate ideas before writing.
b) Organize writing to include a beginning, middle, and end for narrative and expository writing.
c) Expand writing to include descriptive detail. ~~Revise writing for clarity.~~ [Moved to SOL 2.13d]
d) Revise writing for clarity. ~~Use available technology.~~

~~2.12~~ 2.14 The student will edit writing for correct grammar, capitalization, punctuation, and spelling.

a) Recognize and use complete sentences.
b) Use and punctuate declarative, interrogative, and exclamatory sentences.
c) Capitalize all proper nouns and the word *I*.
d) Use singular and plural nouns and pronouns.
e) Use apostrophes in contractions~~, including *don't, isn't,* and *can't*~~ and possessives.
f) Use contractions and singular possessives. ~~Use correct spelling for high-frequency sight words, including compound words and regular plurals.~~ [Moved to SOL 2.14h]
g) Use knowledge of simple abbreviations.
h) Use correct spelling for ~~high-frequency~~ commonly used sight words, including compound words and regular plurals.
i) Use commas in the salutation and closing of a letter.
j) Use verbs and adjectives correctly in sentences.

2.15 The student will use available technology for reading and writing.

Grade Three

Reading continues to be a priority in third grade. Emphasis is on learning about words, reading ~~age-appropriate~~ text with fluency and expression, and learning comprehension strategies. The student will read a variety of fiction and nonfiction ~~literature~~ texts, which relates to all areas of the curriculum. The student will use effective communication skills in group activities and will present brief oral reports. Reading comprehension strategies will be applied in all subjects, with emphasis on materials that reflect the Standards of Learning in mathematics, science, and history and social science. The student will plan, draft, revise, and edit stories, simple explanations, and short reports. In addition, the student will gather and use information from print and ~~nonprint~~ electronic sources. The student also will write legibly in cursive.

Oral Language

3.1 The student will use effective communication skills in group activities.

a) Listen attentively by making eye contact, facing the speaker, asking questions, and summarizing what is said.
b) Ask and respond to questions from teachers and other group members.
c) Explain what has been learned.
d) Use language appropriate for context.
e) Increase listening and speaking vocabularies.

3.2 The student will present brief oral reports using visual media.

a) Speak clearly.
b) Use appropriate volume and pitch.
c) Speak at an understandable rate.
d) Organize ideas sequentially or around major points of information.
e) Use ~~grammatically correct~~ contextually appropriate language and specific vocabulary to communicate ideas.

Reading

3.3 The student will apply word-analysis skills when reading.

a) Use knowledge of ~~all~~ regular and irregular vowel patterns.
b) Decode regular multisyllabic words. ~~Use knowledge of homophones.~~ [Moved to SOL 3.4a]
~~c) Decode regular multisyllabic words.~~ [Moved to SOL 3.3b]

~~3.4 The student will use strategies to read a variety of fiction and nonfiction materials.~~ [Moved to SOL 3.6 and SOL 3.7]

~~a) Preview and use text formats.~~ [Moved to SOL 3.7c]
~~b) Set a purpose for reading.~~
~~c) Apply meaning clues, language structure, and phonetic strategies.~~ [Moved to SOL 3.4c]
~~d) Use context to clarify meaning of unfamiliar words.~~ [Moved to SOL 3.4d]
~~e) Read fiction and nonfiction fluently and accurately.~~ [Moved to SOL 3.5]
~~f) Reread and self-correct when necessary.~~ [Move to Curriculum Framework]

3.4 The student will expand vocabulary when reading.

a) Use knowledge of homophones.
b) Use knowledge of roots, affixes, synonyms, and antonyms.
c) Apply meaning clues, language structure, and phonetic strategies.
d) Use context to clarify meaning of unfamiliar words.
e) Discuss meanings of words and develop vocabulary by listening and reading a variety of texts.
f) Use vocabulary from other content areas.
g) Use word reference resources including the glossary, dictionary, and thesaurus.

3.5 The student will read fiction and nonfiction with fluency, accuracy, and meaningful expression.

~~3.5~~ 3.6 The student will read and demonstrate comprehension of fictional text and poetry.

a) Set a purpose for reading.
b) Make connections between previous experiences and reading selections.
c) Make, confirm, or revise predictions.
d) Compare and contrast settings, characters, and events.
e) Identify the author's purpose.
f) Ask and answer questions about what is read.
g) Draw conclusions about text ~~character and plot~~.
h) Identify the problem and solution. ~~Organize information and events logically.~~
i) Identify the main idea. ~~Summarize major points found in fiction materials~~
j) Identify supporting details. ~~Understand basic plots of fairy tales, myths, folktales, legends, and fables.~~
k) Use reading strategies to monitor comprehension throughout the reading process.~~-~~
l) Differentiate between fiction and nonfiction.

~~3.6~~ 3.7 The student will continue to read and demonstrate comprehension of nonfictional texts.

a) Identify the author's purpose.
b) Use prior and background knowledge as context for new learning. ~~Make connections between previous experiences and reading selections.~~
c) Preview and use text features. ~~Ask and answer questions about what is read.~~ [Moved to SOL 3.7d]
d) Ask and answer questions about what is read. ~~Draw conclusions.~~ [Moved to SOL 3.7e]
e) Draw conclusions based on text. ~~Organize information and events logically.~~
f) Summarize major points found in nonfiction ~~materials~~ texts.
g) Identify the main idea. ~~Identify the characteristics of biographies and autobiographies.~~ [Moved to SOL 3.7i]
h) Identify supporting details. ~~Compare and contrast the lives of two persons as described in biographies and/or autobiographies.~~ [Moved to SOL 3.7i]
i) ~~Identify~~ Compare and contrast the characteristics of biographies and autobiographies.
j) Use reading strategies to monitor comprehension throughout the reading process.~~-~~
k) Identify new information gained from reading.

~~3.7~~ 3.8 The student will use ~~demonstrate~~ comprehension of information from a variety of print and electronic resources. [Moved to SOL 3.4g]

a) Use ~~dictionary, glossary, thesaurus,~~ encyclopedias~~,~~ and other reference books, including online reference materials.
b) Use table of contents, indices, and charts. ~~Use available technology.~~

Writing

~~3.8~~ 3.9 The student will write legibly in cursive.

~~3.9~~ ~~The student will write descriptive paragraphs.~~ [Moved to SOL 3.10]

~~a) Develop a plan for writing.~~
~~b) Focus on a central idea.~~
~~c) Group related ideas.~~
~~d) Include descriptive details that elaborate the central idea.~~
~~e) Revise writing for clarity.~~

3.10 The student will write for a variety of purposes. ~~including stories, letters, simple explanations, and short reports across all content areas.~~

a) Identify the intended audience. ~~Use a variety of planning strategies.~~ [Moved to SOL 3.10b]
b) Use a variety of pre-writing strategies. ~~Organize information according to the type of writing.~~ [Moved to SOL 3.10d]
c) Write a clear topic sentence focusing on the main idea. ~~Identify the intended audience.~~
d) Write a paragraph on the same topic. ~~Revise writing for specific vocabulary and information.~~
e) Organize information according to the type of writing. ~~Use available technology.~~
f) Use strategies for organization and elaboration.
g) Include ~~descriptive~~ details that elaborate the ~~central~~ main idea.
h) Revise writing for clarity of content using specific vocabulary and information

3.11 The student will edit writing for correct grammar, capitalization, punctuation, and spelling.

a) Use complete ~~and varied~~ sentences.
b) Use transition words to vary sentence structure. ~~Use the word *I* in compound subjects.~~ [Moved to SOL 3.11c]
c) Use the word *I* in compound subjects. ~~Use past and present verb tense.~~ [Moved to SOL 3.11d]
d) Use past and present verb tense. ~~Use singular possessives.~~ [Moved to SOL 3.11e]
e) Use singular possessives. ~~Use commas in a simple series.~~ [Moved to SOL 3.11f]
f) Use commas in a simple series. ~~Use simple abbreviations.~~ [Moved to SOL 3.11g]
g) Use simple abbreviations. ~~Use apostrophes in contractions with pronouns.~~ [Moved to SOL 3.11h]
h) Use apostrophes in contractions with pronouns and in possessives. ~~Use correct spelling for high-frequency sight words, including irregular plurals.~~ [Moved to SOL 3.11j]
i) Use the articles *a*, *an*, and *the* correctly.
j) Use correct spelling for ~~high frequency~~ frequently used sight words, including irregular plurals.

3.12 The student will write a short report.

a) Construct questions about the topic.
b) Identify appropriate resources.
c) Collect and organize information about the topic into a short report.
d) Understand the difference between plagiarism and using own words.

3.13 The student will use available technology for reading and writing.

Grade Four

In fourth grade, reading and writing skills support an increased emphasis on content-area learning and utilization of ~~the~~ a variety of resources ~~of the media center, especially~~ to locate and read primary sources of information. A significant percentage of reading material will relate to the study of mathematics, science, and history and social science. The student will use text organizers, summarize information, formulate questions, and draw conclusions to demonstrate reading comprehension. The student will also read classic and contemporary literature selections by a variety of authors. The student will continue to increase communication skills in large- and small-group settings. The introduction of media messages will begin in fourth grade and continue in fifth grade. ~~In addition~~ Additionally, the student will plan, draft, revise, and edit narratives and explanations. The student will ~~also~~ routinely use ~~information resources and~~ word references while writing. The student will demonstrate comprehension of information resources to research a topic and understand the difference between plagiarism and using his/her own words.

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

4.1 The student will use effective oral communication skills in a variety of settings.

a) Present accurate directions to individuals and small groups.
b) Contribute to group discussions across content areas.
c) Seek ideas and opinions of others.
d) Use evidence to support opinions.
e) Use grammatically correct language and specific vocabulary to communicate ideas.
f) Communicate new ideas to others.
g) Demonstrate the ability to collaborate with diverse teams.
h) Demonstrate the ability to work independently.

4.2 The student will make and listen to oral presentations and reports.

a) Use subject-related information and vocabulary.
b) Listen to and record information.
c) Organize information for clarity.
d) Use language and style appropriate to the audience, topic, and purpose.

4.3 The student will learn how media messages are constructed and for what purposes.

a) Differentiate between auditory, visual, and written media messages.
b) Identify the characteristics of various media messages.

Reading

~~4.3~~ 4.4 The student will ~~read fiction and nonfiction with fluency and accuracy~~ expand vocabulary when reading.

a) Use context to clarify meanings of unfamiliar words.
b) Use knowledge of roots, affixes, synonyms, antonyms, and homophones. ~~Explain words with multiple meanings.~~
c) Use word-reference materials, including the glossary, dictionary, and thesaurus. ~~Use knowledge of word origins; synonyms, antonyms, and homonyms; and multiple meanings of words.~~ [Moved to SOL 4.4b]
d) Develop vocabulary by listening to and reading a variety of texts. ~~Use word-reference materials, including the glossary, dictionary, and thesaurus.~~ [Moved to SOL 4.4c]
e) Use vocabulary from other content areas.

4.5 The student will read fiction and nonfiction with fluency, accuracy, and meaningful expression.

~~4.4~~ 4.6 The student will read and demonstrate comprehension of fictional texts, narrative nonfiction texts, and poetry.

a) Explain the author's purpose.
b) Describe how the choice of language, setting, characters, and information contributes to the author's purpose.
c) Identify the main idea. ~~Compare the use of fact and fantasy in historical fiction with other forms of literature.~~
d) Summarize supporting details. ~~Identify major events and supporting details~~. [Moved to SOL 4.6c and SOL 4.6d]
e) Identify the problem and solution. ~~Describe the relationship between text and previously read materials.~~ [Moved to SOL 4.6f]
f) Describe the relationship between text and previously read materials. ~~Identify sensory words.~~ [Moved to SOL 4.6g]
g) Identify sensory words.
h) Draw conclusions/make inferences about text.
i) Make, confirm, or revise predictions.
j) Use reading strategies throughout the reading process to monitor comprehension.

~~4.5~~ 4.7 The student will read and demonstrate comprehension of nonfictional texts.

a) Use text ~~organizers~~ structures, such as type, headings, and graphics, to predict and categorize information in both print and digital texts.
b) Formulate questions that might be answered in the selection.
c) Explain the author's purpose.
d) Identify the main idea. ~~Make simple inferences, using information from texts.~~ [Moved to Sol 4.7f]
e) Summarize supporting details. ~~Draw conclusions, using information from texts.~~[Moved to SOL 4.7f]
f) Draw conclusions and make simple inferences using textural information as support. ~~Summarize content of selection, identifying important ideas and providing details for each important idea.~~ [Moved to SOL 4.7d and SOL 4.7e]
g) Distinguish between cause and effect. ~~Describe relationship between content and previously learned concepts or skills.~~ [Moved to SOL 4.7i]
h) Distinguish between ~~cause and effect and between~~ fact and opinion.
i) Use prior knowledge and build additional background knowledge as context for new learning. ~~Identify new information gained from reading.~~ [Moved to SOL 4.7j]
j) Identify new information gained from reading.
k) Use reading strategies throughout the reading process to monitor comprehension.

~~4.6~~ ~~The student will demonstrate comprehension of information resources to research a topic.~~ [Moved to SOL 4.10]

~~a) Construct questions about a topic.~~
~~b) Collect information, using the resources of the media center, including online, print, and media resources.~~
~~c) Evaluate and synthesize information.~~

Writing

~~4.7~~ 4.8 The student will write ~~effective~~ cohesively ~~narratives, poems, and explanations~~ for a variety of purposes.

a) Identify intended audience. ~~Focus on one aspect of a topic.~~ [Moved to SOL 4.8b]
b) Focus on one aspect of a topic. ~~Develop a plan for writing.~~ [Moved to SOL 4.8c]
c) Use a variety of pre-writing strategies. ~~Organize writing to convey a central idea.~~ [Moved to SOL 4.8d]
d) Organize writing to convey a central idea. ~~Write several related paragraphs on the same topic.~~ [Moved to SOL 4.8g]
e) Recognize different modes of writing have different patterns of organization. ~~Utilize elements of style, including word choice and sentence variation.~~
f) Write a clear topic sentence focusing on the main idea. ~~Write rhymed, unrhymed, and patterned poetry.~~ [Move to Curriculum Framework]
g) Write two or more related paragraphs on the same topic. ~~Use available technology.~~
h) Use transition words for sentence variety.
i) Utilize elements of style, including word choice and sentence variation.
j) Revise writing for clarity of content using specific vocabulary and information.

~~4.8~~ 4.9 The student will edit writing for correct grammar, capitalization, spelling, punctuation, ~~and~~ sentence structure, and paragraphing.

a) Use subject-verb agreement.
b) Include prepositional phrases.
c) Eliminate double negatives.
d) Use noun-pronoun agreement.
e) Use commas in series, dates, and addresses.
f) Incorporate adjectives and adverbs.
~~g)~~ ~~Use the articles *a*, *an*, and *the* correctly.~~ [Moved to SOL 3.11i]
~~h)~~g Use correct spelling for frequently used words, including common homophones.
h) Use singular possessives.

Research

4.10 The student will demonstrate comprehension of information resources to research a topic.

a) Construct questions about a topic.
b) Collect information from multiple resources including online, print, and media.
c) Use technology as a tool to organize, evaluate and communicate information.
d) Give credit to sources used in research.
e) Understand the difference between plagiarism and using own words.

Grade Five

In fifth grade, reading and writing skills continue to support an increased emphasis on content-area learning and utilization of ~~the~~ a variety of resources ~~of the media center, especially~~ to locate and read primary sources of information. The student will read texts in all subjects and will acquire information to answer questions, generate hypotheses, make inferences, support opinions, confirm predictions, compare and contrast relationships, and formulate conclusions. The student will continue to develop an appreciation for literature by reading a variety of fiction and nonfiction selections. The student will continue to increase communication skills used in learning activities and create a project us~~e~~ing online, print, and media resources ~~to prepare presentations~~. The student will use oral and written communication skills to describe key concepts and information contained in the mathematics, science, and history and social science Standards of Learning. In addition, the student will plan, draft, revise, and edit writings to describe, to entertain, ~~and~~ to explain, and to persuade. The student will define the meaning and consequences of plagiarism.

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

5.1 The student will listen, draw conclusions, and share responses in subject-related group learning activities.

a) Participate in and contribute to discussions across content areas.
b) Organize information to present in reports of group activities.
c) Summarize information gathered in group activities.
d) Communicate new ideas to others.
e) Demonstrate the ability to collaborate with diverse teams.
f) Demonstrate the ability to work independently.

5.2 The student will use effective verbal and nonverbal communication skills to deliver planned oral presentations.

a) Maintain eye contact with listeners.
b) Use gestures to support, accentuate, and dramatize verbal message.
c) Use facial expressions to support and dramatize verbal message.
d) Use posture appropriate for communication setting.
e) Determine appropriate content for audience
f) Organize content sequentially around major ideas.
g) Summarize main points as they relate to main idea or supporting details.
h) Incorporate visual media to support the presentation.
i) Use language and style appropriate to the audience, topic, and purpose.

~~5.3~~ ~~The student will make planned oral presentations.~~ [Moved SOL to 5.2]

~~a) Determine appropriate content for audience.~~
~~b) Organize content sequentially or around major ideas~~.
~~c) Summarize main points before or after presentation~~
~~d) Incorporate visual aids to support the presentation.~~]
~~e) Use grammatically correct language and specific vocabulary.~~

5.3 The student will learn how media messages are constructed, and for what purposes.

a) Differentiate between auditory, visual, and written media messages.
b) Identify the characteristics and effectiveness of a variety of media messages.

Reading

5.4 The student will ~~read fiction and nonfiction with fluency and accuracy~~ expand vocabulary when reading.

a) Use context to clarify meaning of unfamiliar words and phrases.
b) Use context and sentence structure to determine meanings and differentiate among multiple meanings of words. ~~Use knowledge of root words, prefixes, and suffixes.~~ [Moved to SOL 5.4c]
c) Use knowledge of roots, affixes, synonyms, antonyms, and homophones. ~~Use dictionary, glossary, thesaurus, and other word-reference materials.~~ [Moved to SOL 5.4e]
d) Identify an author's use of figurative language.
e) Use dictionary, glossary, thesaurus, and other word-reference materials.
f) Develop vocabulary by listening to and reading a variety of texts.
g) Study word meanings across content areas.

5.5 The student will read fiction and nonfiction with fluency, accuracy, and meaningful expression.

~~5.5~~ 5.6 The student will read and demonstrate comprehension of fictional texts, narrative nonfiction, and poetry.

a) Describe the relationship between text and previously read materials.
b) Describe character development. ~~in fiction and poetry selections.~~
c) Describe the development of plot and explain ~~how conflicts are resolved~~ the resolution of conflict(s).
d) Describe the characteristics of free verse, rhymed, and patterned poetry.
e) Describe how an author's choice of vocabulary ~~and style~~ contributes to the ~~quality and enjoyment of selections to the~~ author's style.
f) Identify and ask questions that clarify various points of view.
g) Identify main idea.
h) Summarize supporting details from text.
i) Draw conclusions and make inferences from text.
j) Identify cause-effect relationships.
k) Make, confirm, or revise predictions.
l) Use reading strategies throughout the reading process to monitor comprehension.

~~5.6~~ 5.7 The student will read and demonstrate comprehension of nonfictional texts.

a) Use text organizers, such as type, headings, and graphics, to predict and categorize information in both print and digital texts.
b) Use prior knowledge and build additional background knowledge as context for new learning. ~~Identify structural patterns found in nonfiction.~~ [Moved to SOL 5.7f]
c) Skim materials to develop a general overview of content and to locate specific information. ~~Locate information to support opinions, predictions, and conclusions.~~ [Moved to SOL 5.7g]
d) Identify the main idea of nonfictional texts. ~~Identify cause-and-effect relationships.~~ [Moved to SOL 5.7h]
e) Summarize supporting details in nonfictional texts. ~~Identify compare-and-contrast relationships.~~ [Moved to SOL 5.7j]
f) Identify structural patterns found in nonfiction. ~~Skim materials to develop a general overview of content and to locate specific information.~~ [Moved to SOL 5.7c]
g) Locate information to support opinions, predictions, and conclusions. ~~Identify new information gained from reading.~~ [Moved to SOL 5.7k]
h) Identify cause-and-effect relationships following transition words signaling the pattern.
i) Differentiate between fact and opinion.
j) Identify, compare, and contrast relationships.
k) Identify new information gained from reading.
l) Use reading strategies throughout the reading process to monitor comprehension.

~~5.7~~ ~~The student will demonstrate comprehension of information from a variety of print resources.~~

~~a) Develop notes that include important concepts, summaries, and identification of information sources.~~ [Moved to SOL 5.10e]
~~b) Organize information on charts, maps, and graphs.~~[Moved to SOL 5.10d]

Writing

5.8 The student will write for a variety of purposes: to describe, to inform, to entertain, ~~and~~ to explain, and to persuade.

a) Identify intended audience. ~~Choose planning strategies for various writing purposes.~~ [Moved to SOL 5.8b]
b) Use a variety of prewriting strategies. ~~Organize information.~~ [Moved to SOL 5.8c]
c) Organize information to convey a central idea. ~~Demonstrate awareness of intended audience.~~ [Moved to SOL 5.8a]
d) Write a clear topic sentence focusing on the main idea. ~~Use precise and descriptive vocabulary to create tone and voice.~~ [Moved to SOL 5.8 f]
e) Write multiparagraph compositions. ~~Vary sentence structure.~~ [Moved to SOL 5.8 g]
f) Use precise and descriptive vocabulary to create tone and voice. ~~Revise writing for clarity.~~ [Moved to SOL 5.8h]
g) Vary sentence structure by using transition words. ~~Use available technology to access information.~~ [Moved to SOL 5.10c]
h) Revise for clarity of content using specific vocabulary and information.

5.9 The student will edit writing for correct grammar, capitalization, spelling, punctuation, ~~and~~ sentence structure, and paragraphing.

a) Use plural possessives.
b) Use adjective and adverb comparisons.
c) Identify and use interjections.
d) Use apostrophes in contractions and possessives.
e) Use quotation marks with dialogue.
f) Use commas to indicate interrupters. ~~and in the salutation and closing of a letter.~~
g) Use a hyphen to divide words at the end of a line.
h) Edit for ~~clausal~~ fragments~~,~~ and run-on sentences~~, and excessive coordination~~.
i) Eliminate double negatives.
j) Use correct spelling of commonly used words.

Research

5.10 The student will find, evaluate, and select appropriate resources for a research product.

a) Construct questions about a topic.
b) Collect information from multiple resources including online, print, and media.
c) Use technology as a tool to research, organize, evaluate, and communicate information.
d) Organize information presented on charts, maps, and graphs.
e) Develop notes that include important concepts, summaries, and identification of information sources.
f) Give credit to sources used in research.
g) Define the meaning and consequences of plagiarism.

Grade Six

The sixth-grade student will be an active participant in classroom discussions. The student will present personal opinions, understand differing viewpoints, distinguish between fact and opinion, and analyze the effectiveness of group communication. The student will continue in the study of the elements of media literacy as introduced in earlier grades. The student will begin the study of word origins and continue vocabulary development. The student will read independently a variety of fiction and nonfiction texts, including a significant number of classic works, for appreciation and comprehension. The student will also plan, draft, revise, and edit narratives, descriptions, and explanations, with attention to composition and style as well as sentence formation, usage, and mechanics. The student will also demonstrate correct use of language, spelling, and mechanics by applying grammatical conventions in writing and speaking. In addition, ~~reading and writing will be used as tools for learning academic concepts, and available~~ technology will be used ~~as appropriate~~ as a tool to research, organize, and communicate information. As in earlier grades, the meaning and consequences of plagiarism will be stressed.

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

6.1 The student will ~~analyze oral~~ participate~~ion~~ in and contribute to small-group activities.
- a) Communicate as leader and contributor.
- b) Evaluate own contributions to discussions.
- c) Summarize and evaluate group activities.
- d) Analyze the effectiveness of participant interactions.

6.2 The student will present, listen critically and express opinions in oral presentations.
- a) Distinguish between fact and opinion.
- b) Compare and contrast viewpoints.
- c) Present a convincing argument.
- d) Paraphrase and summarize what is heard.
- e) ~~Summarize what is heard.~~ [Moved to SOL 6.2d]
- ~~f)~~ e) Use ~~grammatically correct~~ language and vocabulary appropriate to audience, topic, and purpose.

6.3 The student will understand the elements of media literacy.
- a) Compare and contrast auditory, visual, and written media messages.
- b) Identify the characteristics and effectiveness of a variety of media messages.
- c) Craft and publish audience-specific media messages.

Reading

~~6.3~~ 6.4 The student will read and learn the meanings of unfamiliar words and phrases within authentic texts.

a) Identify word origins~~,~~ and derivations~~, and inflections~~.
b) Use roots, cognates, affixes, synonyms, and antonyms to expand vocabulary. ~~Identify analogies and figurative language~~. [Moved to SOL 6.4d]
c) Use context and sentence structure to determine meanings and differentiate among multiple meanings of words.
d) Identify and analyze figurative language. ~~Use word-reference materials~~. [Moved to SOL 6.4e]
e) Use word-reference materials.
f) Extend general and specialized vocabulary through speaking, listening, and writing.

~~6.4~~ 6.5 The student will read and demonstrate comprehension of a variety of fictional texts, narrative nonfiction, and poetry.

a) Identify the elements of narrative structure, including setting, character, plot, conflict, and theme.
b) Make, confirm, and revise predictions. ~~Use knowledge of narrative and poetic structures to aid comprehension and predict outcomes.~~
c) Describe how word choice and imagery contribute to the meaning of a text. ~~Describe the images created by language~~.
d) Describe cause-effect relationships and their impact on plot. ~~Describe how word choice and imagery contribute to the meaning of a text~~. [Moved to SOL 6.5c]
~~e) Describe cause-effect relationships and their impact on plot~~. [Moved to SOL 6.5d]
e) Use prior and background knowledge as context for new learning. ~~Use information stated explicitly in the text to draw conclusions and make inferences~~. [Moved to SOL 6.5g]
f) Use information in the text to draw conclusions and make inferences. ~~Explain how character and plot development are used in a selection to support a central conflict or story line.~~ [Moved to SOL 6.5h]
g) Explain how character and plot development are used in a selection to support a central conflict or story line. ~~Paraphrase and summarize the main points in the text~~. [Moved to SOL 6.5i]
h) Identify the main idea.
i) Identify and summarize supporting details.
j) Identify and analyze the author's use of figurative language.
k) Identify transitional words and phrases that signal an author's organizational pattern.
l) Use reading strategies to monitor comprehension throughout the reading process.

~~6.5~~ 6.6 The student will read and demonstrate comprehension of a variety of ~~informational selections~~ nonfictional texts.

a) Use text structures such as type, headings, and graphics to predict and categorize information in both print and digital texts. ~~Identify questions to be answered.~~ [Moved to SOL 6.6c]
b) Use prior knowledge and build additional background knowledge as context for new learning. ~~Make, confirm, or revise predictions~~. [Moved to SOL 6.6d]
c) Identify questions to be answered. ~~Use context to determine meanings of unfamiliar words and technical vocabulary.~~
d) Make, confirm, or revise predictions. ~~Draw conclusions and make inferences based on explicit and implied information.~~ [Moved to SOL 6.6e]
e) Draw conclusions and make inferences based on explicit and implied information. ~~Organize the main idea and details to form a summary.~~ [Moved to SOL 6.6g]
f) Differentiate between fact and opinion. ~~Compare and contrast information about one topic contained in different selections~~. [Moved to SOL 6.6h]
g) Identify main idea. ~~Select informational sources appropriate for a given purpose.~~ [Moved to SOL 6.9]
h) Summarize supporting details.
i) Compare and contrast information about one topic, which may be contained in different selections.
j) Identify the author's organizational pattern.
k) Identify cause-effect relationships.
l) Use reading strategies to monitor comprehension throughout the reading process.

Writing

~~6.6~~ 6.7 The student will write narration, description, and exposition ~~narratives, descriptions, and explanations~~.

a) Identify audience and purpose. ~~Use a variety of planning strategies to generate and organize ideas~~. [Moved to SOL 6.7b]
b) Use a variety of prewriting strategies including graphic organizers to generate and organize ideas. ~~Establish central idea, organization, elaboration, and unity~~. [Moved to SOL 6.7d]
c) Organize writing structure to fit mode or topic. ~~Select vocabulary and information to enhance the central idea, tone, and voice.~~ [Moved to SOL 6.7g]
d) Establish a central idea and organization. ~~Expand and embed ideas by using modifiers, standard coordination, and subordination in complete sentences.~~ [Moved to SOL 6.7h]
e) Compose a topic sentence or thesis statement if appropriate. ~~Revise writing for clarity.~~ [Moved to SOL 6.7i]
f) Write multiparagraph compositions with elaboration and unity.
g) Select vocabulary and information to enhance the central idea, tone, and voice.
h) Expand and embed ideas by using modifiers, standard coordination, and subordination in complete sentences.
i) Revise sentences for clarity of content including specific vocabulary and information.
j) Use computer technology to plan, draft, revise, edit and publish writing.

~~6.7~~ 6.8 The student will edit writing for correct grammar, capitalization, punctuation, spelling, ~~and~~ sentence structure, and paragraphing.

a) Use a variety of graphic organizers, including sentence diagrams, to analyze and improve sentence formation and paragraph structure.
b) Use subject-verb agreement with intervening phrases and clauses.
c) Use pronoun-antecedent agreement to include indefinite pronouns.
d) Maintain consistent ~~tense inflections~~ verb tense across paragraphs.
e) Eliminate double negatives. ~~Choose adverbs to describe verbs, adjectives, and other adverbs~~. [Move to SOL 6.8g]
f) Use quotation marks with dialogue. ~~Use correct spelling for frequently used words.~~ [Move to SOL 6.8h]
g) Choose adverbs to describe verbs, adjectives, and other adverbs.
h) Use correct spelling for frequently used words.

Research

6.9 The student will find, evaluate and select appropriate resources for a research product.

a) Collect information from multiple sources including online, print, and media.
b) Evaluate the validity and authenticity of texts.
c) Use technology as a tool to research, organize, evaluate, and communicate information.
d) Cite primary and secondary sources.
e) Define the meaning and understand the consequences of plagiarism following ethical, legal guidelines in gathering and using information.

Grade Seven

The seventh-grade student will continue to develop oral communication skills and will become more knowledgeable of the effects of verbal and nonverbal behaviors in oral communication. The student will continue to read a wide variety of fiction, nonfiction, and poetry while becoming more independent and analytical. The student will continue to refine written composition skills, with special attention to word choice, organization, style, and grammar. Written explanations will utilize informational writing skills, and persuasive writing will be introduced. The student will continue vocabulary development through a study of figurative language and continuing study of roots, ~~and~~ affixes, and cognates. Knowledge of the ~~impact~~ informative/persuasive techniques of media messages ~~on public opinion~~ will be ~~introduced~~ studied. The student will ~~increase proficiency in the use of print and electronic information resources and will learn ways to give credit to reference sources~~ apply research techniques to gather, organize, and communicate information, properly citing sources. The student will also demonstrate correct use of language, spelling, and mechanics by applying grammatical conventions in writing and speaking.

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

7.1 The student will ~~give and seek information~~ particpate in and contribute to conversations, ~~in~~ group discussions, and ~~in~~ oral presentations.

a) Communicate ideas and information orally in an organized and succinct manner. ~~Use oral vocabulary and style appropriate for listeners.~~
b) Ask probing questions to seek elaboration and clarification of ideas. ~~Communicate ideas and information orally in an organized and succinct manner.~~ [Moved to SOL 7.1a]
c) Make statements to communicate agreement or tactful disagreement with others' ideas. ~~Ask probing questions to seek elaboration and clarification of ideas.~~ [Moved to SOL 7.1b]
d) Use language and style appropriate to audience, topic, and purpose. ~~Make supportive statements to communicate agreement with or acceptance of others' ideas.~~ [Moved to SOL 7.1c]
e) Use a variety of strategies to listen actively. ~~Use grammatically correct language and vocabulary appropriate to audience, topic, and purpose.~~ [Moved to SOL 7.1d]

7.2 The student will identify and demonstrate the relationship between a speaker's verbal and nonverbal messages.

a) Use verbal communication skills, such as word choice, pitch, feeling, tone, and voice appropriate for the intended audience.
b) Use nonverbal communication skills, such as eye contact, posture, and gestures to enhance verbal communication skills.
c) Compare/contrast a speaker's verbal and nonverbal messages.

7.3 The student will understand the elements of media literacy. ~~The student will describe persuasive messages in nonprint media, including television, radio, and video.~~ [Moved to SOL 7.3a]

a) Identify persuasive/informative techniques used in nonprint media including television, radio, video, and Internet.
b) Distinguish between fact, ~~and~~ opinion, evidence, and inference.
c) Describe how word choice and visual images convey~~s~~ a viewpoint.
d) Compare and contrast the techniques in auditory, visual, and written media messages.
e) Craft and publish audience-specific media messages.

Reading

7.4 The student will read to determine the meanings and pronunciations of unfamiliar words and phrases within authentic texts.

a) Identify word origins and derivations. ~~Use roots and affixes to expand vocabulary.~~ [Moved to SOL 7.4b]
b) Use roots, cognates, affixes, synonyms, and antonyms to expand vocabulary. ~~Recognize analogies and figurative language~~. [Moved to SOL 7.4c]
c) Identify and analyze figurative language. ~~Identify connotations.~~ [Moved to SOL 7.4d]
d) Identify connotations.
e) Use context and sentence structure to determine meanings and differentiate among multiple meanings of words.
f) Extend general and specialized vocabulary through speaking, listening, reading, and writing.

7.5 The student will read and demonstrate comprehension of a variety of fictional texts, narrative nonfiction, and poetry.

a) Describe the elements of narrative structure including setting, character development, plot structure, theme, and conflict.
b) Compare and contrast various forms and genres of fictional text. ~~Compare and contrast forms, including short stories, novels, plays, folk literature, poetry, essays, and biographies.~~
c) Identify conventional elements and characteristics of a variety of genres. ~~Describe the impact of word choice, imagery, and poetic devices~~. [Moved to SOL 7.5d]
d) Describe the impact of word choice, imagery, and literary devices including figurative language. ~~Explain how form, including rhyme, rhythm, repetition, line structure, and punctuation, conveys the mood and meaning of a poem.~~ [Move to Curriculum Framework]
e) Make, confirm, and revise predictions. ~~Draw conclusions based on explicit and implied information.~~ [Moved to SOL 7.5g]
f) Use prior and background knowledge as a context for new learning. ~~Make inferences based on explicit and implied information.~~ [Moved to SOL 7.5g]
g) Make inferences and draw conclusions based on the text. ~~Summarize text~~. [Moved to SOL 7.5h]
h) Identify the main idea.
i) Summarize text relating supporting details.
j) Identify the author's organizational pattern.
k) Identify cause-effect relationships.
l) Use reading strategies to monitor comprehension throughout the reading process.

7.6 The student will read and demonstrate comprehension of a variety of ~~informational~~ nonfictional texts.

a) Use prior and background knowledge as a context for new learning. ~~Use knowledge of text structures to aid comprehension.~~ [Moved to SOL 7.6b]
b) Use text structures to aid comprehension. ~~Use knowledge of words and phrases that signal an author's organizational pattern to aid comprehension~~. [Moved to SOL 7.6c]
c) Identify an author's organizational pattern using textural clues, such as transitional words and phrases. ~~Distinguish fact from opinion in newspapers, magazines, and other print media~~. [Moved to SOL 7.6e]
d) Draw conclusions and make inferences on explicit and implied information. ~~Identify the source, viewpoint, and purpose of texts~~. [Moved to SOL 7.6f]
e) Differentiate between fact and opinion. ~~Describe how word choice and language structure convey an author's viewpoint~~. [Moved to SOL 7.6g]
f) Identify the source, viewpoint, and purpose of texts. ~~Summarize what is read.~~ [Moved to SOL 7.6g]
g) Describe how word choice and language structure convey an author's viewpoint. ~~Organize and synthesize information for use in written and oral presentations.~~ [Moved to SOL 7.6k]
h) Identify the main idea.
i) Summarize text identifying supporting details.
j) Identify cause-effect relationships.
k) Organize and synthesize information for use in written formats.
l) Use reading strategies to monitor comprehension throughout the reading process.

~~7.7~~ ~~The student will apply knowledge of appropriate reference materials.~~ [Moved to SOL 7.9]

a) ~~Use print and electronic sources to locate information in books and articles.~~
b) ~~Use graphic organizers to organize information.~~
c) ~~Synthesize information from multiple sources.~~
d) ~~Credit primary and secondary sources.~~

Writing

~~7.8~~ 7.7 The student will ~~develop narrative, expository, and persuasive writing~~ write in a variety of forms with an emphasis on exposition, narration, and persuasion.

a) Identify intended audience. ~~Apply knowledge of prewriting strategies.~~ [Moved to SOL 7.7 b]
b) Use a variety of prewriting strategies including graphic organizers to generate and organize ideas. ~~Elaborate the central idea in an organized manner.~~ [Moved to SOL 7.7d]
c) Organize writing structure to fit mode or topic. ~~Choose vocabulary and information that will create voice and tone~~. [Moved SOL to 7.7g]
d) Establish a central idea and organization. ~~Use clauses and phrases to vary sentences~~. [Moved SOL to 7.7i]
e) Compose a topic sentence or thesis statement. ~~Revise writing for clarity and effect~~. [Moved to SOL 7.7j]
f) Write multiparagraph compositions with unity elaborating the central idea. ~~Use a word processor to plan, draft, revise, edit, and publish selected writings.~~ [Moved to SOL 7.7k]
g) Select vocabulary and information to enhance the central idea, tone, and voice.
h) Expand and embed ideas by using modifiers, standard coordination, and subordination in complete sentences.
i) Use clauses and phrases for sentence variety.

j) Revise sentences for clarity of content including specific vocabulary and information.
k) Use computer technology to plan, draft, revise, edit and publish writing.

~~7.9~~ 7.8 The student will edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure, and paragraphing.

a) Use a variety of graphic organizers, including sentence diagrams, to analyze and improve sentence formation and paragraph structure.
b) Choose appropriate adjectives and adverbs to enhance writing. ~~Demonstrate understanding of sentence formation by identifying the eight parts of speech and their functions in sentences.~~ [Move to SOL 7.8f]
c) Use pronoun-antecedent agreement to include indefinite pronouns. ~~Choose pronouns to agree with antecedents.~~
d) Use subject-verb agreement with intervening phrases and clauses.
e) Edit for verb tense consistency and point of view.
f) Demonstrate understanding of sentence formation by identifying the eight parts of speech and their functions in sentences.
g) Use quotation marks with dialogue.
h) Use correct spelling for commonly used words.

Research

7.9 The student will apply knowledge of appropriate reference materials to produce a research product.

a) Collect and organize information from multiple sources including online, print and media.
b) Evaluate the validity and authenticity of sources.
c) Use technology as a tool to research, organize, evaluate and communicate information.
d) Cite primary and secondary sources.
e) Define the meaning and consequences of plagiarism following ethical and legal guidelines and using information.

Grade Eight

The eighth-grade student will learn and apply interviewing techniques developing and delivering oral presentations in groups and individually. The student will demonstrate correct use of language, spelling, and mechanics by applying grammatical conventions in writing and speaking. Students will evaluate, analyze, develop and produce media messages. The student will plan, draft, revise, and edit writing, with emphasis on exposition and persuasion. The student will apply reading and writing skills in all subjects, as well as respond critically to literature. The student will continue development of vocabulary, with attention to connotations and figurative language. ~~The student will become a skillful interpreter of the persuasive strategies used in print and mass media.~~ The student will continue to develop an appreciation for ~~literature~~ literary genres through a study of a wide variety of selections. The student will describe themes, make inferences ~~or inferred main ideas~~, interpret cause-effect relationships, differentiate between fact and opinion, and draw conclusions from a variety of ~~literary and informational selections~~ texts.

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

8.1 The student will use interviewing techniques to gain information.

a) Prepare and ask relevant questions for the interview.
b) Make notes of responses.
c) Compile and accurately report, and publish responses.
d) Evaluate the effectiveness of the interview.

8.2 The student will develop and deliver oral presentations in groups and individually.

a) Choose topic and purpose appropriate to the audience.
b) Choose vocabulary and tone appropriate to the audience, topic, and purpose.
c) Use appropriate verbal and nonverbal presentation skills.
d) Respond to audience questions and comments.
e) Differentiate between standard English and informal language. ~~Use grammatically correct language~~.
f) Critique oral presentations.
g) Assume shared responsibility for collaborative work.
h) Use a variety of strategies to listen actively.

8.3 The student will analyze, develop, and produce creative or informational ~~mass~~ media messages.

a) Evaluate the persuasive/informational technique being used in nonprint media including television, radio, video, and Internet.
b) Examine how values and viewpoints are included or excluded and how the media can influence beliefs, behaviors, and interpretations. ~~Describe the possible cause-effect relationships between mass media coverage and public opinion trends.~~ [Moved to SOL 9.2c]
c) Use media and visual literacy skills to create products that express new understandings. ~~Evaluate sources, including advertisements, editorials, and feature stories, for relationships between intent and factual content.~~ [Moved to SOL 8.3d]
d) Evaluate sources for relationships.
e) Monitor, analyze, and use multiple streams of simultaneous information.

Reading

8.4 The student will apply knowledge of word origins, derivations, ~~inflections,~~ analogies, and figurative language to extend vocabulary development within authentic texts.

a) Identify and analyze an author's use of figurative language. ~~Identify simile, metaphor, personification, hyperbole, and analogy~~. [Move to Curriculum Framework]
b) Use context, structure, and connotations to determine meaning and differentiate among multiple meanings of words and phrases.
c) Use roots, affixes, cognates, synonyms, and antonyms to determine the meaning of unfamiliar words and technical vocabulary.
d) Use dictionaries, thesauruses, and glossaries to determine definition, pronunciation, etymology, spelling, and usage of words.
e) Discriminate between connotative and denotative meanings and interpret the connotative power of words.
f) Extend general and specialized vocabulary through speaking, listening, reading, and writing.

8.5 The student will read and analyze a variety of ~~narrative and poetic forms~~ fictional texts, narrative nonfiction, and poetry.

a) Explain the use of symbols and figurative language.
b) Make inferences and draw conclusions based on explicit and implied information using evidence from text as support. ~~Describe inferred main ideas or themes, using evidence from the text as support~~.
c) ~~Describe~~ Identify how authors use characters, conflict, point of view, voice, and tone to create meaning.
d) Understand the author's use of conventional elements and characteristics within a variety of genres. ~~Compare and contrast the use of the poetic elements of word choice, dialogue, form, rhyme, rhythm, and voice~~. [Moved to SOL 8.5e]
e) Compare and contrast the use of word choice, dialogue, form, rhyme, rhythm, and voice. ~~Compare and contrast authors' styles.~~ [Moved to SOL 8.5f]
f) Compare and contrast authors' styles.
g) Identify and ask significant questions that clarify various viewpoints.
h) Identify the main idea.
i) Summarize text relating supporting details.
j) Identify an author's organizational pattern using textural clues, such as transitional words and phrases.
k) Identify cause-effect relationships.
l) Use prior and background knowledge as a context for new learning.
m) Use reading strategies to monitor comprehension throughout the reading process.

8.6 The student will read, comprehend, and analyze a variety of ~~informational~~ nonfictional texts ~~sources~~.

a) Draw on background knowledge and knowledge of text structure to understand selections.
b) Make inferences and draw conclusions based on explicit and implied information using evidence from text as support. ~~Analyze the author's credentials, viewpoint, and impact.~~ [Moved to SOL 8.6c]
c) Analyze the author's qualifications, viewpoint, and impact. ~~Analyze the author's use of text structure and word choice.~~ [Moved to SOL 8.6d]
d) Analyze the author's use of text structure and word choice. ~~Analyze details for relevance and accuracy.~~ [Moved to SOL 8.6e]
e) Analyze details for relevance and accuracy. ~~Read and follow instructions to complete an assigned task~~.
f) Differentiate between fact and opinion. ~~Summarize and critique text.~~ [Moved to SOL 8.6g]
g) Identify the main idea. ~~Evaluate and synthesize information to apply in written and oral presentations~~. [Moved to SOL 8.6k]
h) Summarize the text identifying supporting details. ~~Draw conclusions based on explicit and implied information~~. [Moved to SOL 8.6b]
i) Identify an author's organizational pattern using textural clues, such as transitional words and phrases. ~~Make inferences based on explicit and implied information.~~ [Moved to SOL 8.6b]
j) Identify cause-effect relationships.
k) Evaluate, organize, and synthesize information for use in written and oral formats.
l) Use reading strategies to monitor comprehension throughout the reading process.

Writing

8.7 The student will write in a variety of forms, including ~~narrative, expository, persuasive~~, narration, exposition, persuasion, and informational.

a) Identify intended audience. ~~Use prewriting strategies to generate and organize ideas~~. [Moved to SOL 8.7b]
b) Use prewriting strategies to generate and organize ideas. ~~Organize details to elaborate the central idea~~. [Moved to SOL 8.7d]
c) Distinguish between a thesis statement and a topic sentence. ~~Select specific vocabulary and information~~. [Moved to SOL 8.6e]
d) Organize details to elaborate the central idea and provide unity. ~~Revise writing for word choice, sentence variety, and transitions among paragraphs.~~ [Moved to SOL 8.7g]
e) Select specific vocabulary and information for audience and purpose. ~~Use available technology~~. [Moved to new SOL 8.7h]
f) Use interview quotations as evidence.
g) Revise writing for clarity of content, word choice, sentence variety, and transitions among paragraphs.
h) Use computer technology to plan, draft, revise, edit and publish writing.

8.8 The student will edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure, and paragraphing.

a) Use a variety of graphic organizers, including sentence diagrams, to analyze and improve sentence formation and paragraph structure.
b) Use and punctuate correctly varied sentence structures to include conjunctions and transition words.
c) Choose the correct case and number for pronouns in prepositional phrases with compound objects.
d) Maintain consistent verb tense across paragraphs.
e) Use comparative and superlative degrees in adverbs and adjectives.
f) Use quotation marks with dialogue and direct quotations.
g) Use correct spelling for frequently used words.

Research

8.9 The student will apply knowledge of appropriate reference materials to produce a research product.

a) Collect and synthesize information from multiple sources including online, print and media.
b) Evaluate the validity and authenticity of texts.
c) Use technology as a tool to research, organize, evaluate and communicate information.
d) Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, point of view or bias.
e) Cite primary and secondary sources using Modern Language Association (MLA) or American Psychological Association (APA) style.
f) Publish findings and respond to feedback.
g) Define the meaning and consequences of plagiarism following ethical and legal guidelines for gathering and using information.

Grade Nine

The ninth-grade student will ~~plan~~ make planned oral presentations independently and in small groups ~~present, and critique dramatic readings of literary selections~~. Knowledge of the impact that informative/persuasive techniques in media messages make on public opinion will be introduced. The student will continue development of vocabulary, with attention to connotations, idioms, and allusions. Knowledge of literary terms and ~~forms~~ genres will be applied in the student's own writing and in the analysis of literature. The student will be introduced to significant literary ~~works~~ texts. Increased requirements for research and reporting in all subjects will be supported by the use of print, electronic databases, online resources, and ~~a standard style sheet method to cite reference sources~~ other media. Students will cite sources of information using a standard method of documentation. The student will distinguish between reliable and questionable ~~Internet~~ sources of information. Writing will encompass narrative, ~~literary~~, expository, and ~~informational~~ persuasive forms ~~, with particular attention to analysis~~ for a variety of purposes and audiences. The student will demonstrate correct use of language, spelling, and mechanics by applying grammatical conventions in writing and speaking.

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

~~9.1~~ ~~The student will plan, present, and critique dramatic readings of literary selections.~~

a) ~~Choose a literary form for presentation, such as a poem, monologue, scene from a play, or story.~~
b) ~~Adapt presentation techniques to fit literary form.~~
c) ~~Use verbal and nonverbal techniques for presentation.~~
d) ~~Evaluate impact of presentation.~~ [Moved to SOL 9.1f]

~~9.2~~ 9.1 The student will make planned oral presentations independently and in small groups.

a) Include definitions to increase clarity.
b) Use relevant details to support main ideas.
c) Illustrate main ideas through anecdotes and examples.
d) Use grammatically correct language, including vocabulary appropriate to the topic, audience, and purpose. ~~Cite information sources~~. [Moved to SOL 9.1g]
e) Use verbal and nonverbal techniques for presentation. ~~Make impromptu responses to questions about presentation.~~ [Moved to SOL 9.1h]
f) Evaluate impact and purpose of presentation. ~~Use grammatically correct language, including vocabulary appropriate to the topic, audience, and purpose.~~ [Moved to SOL 9.1d]
g) Credit information sources.
h) Give impromptu responses to questions about presentation.
i) Give and follow spoken directions to perform specific tasks, answer questions, or solve problems.
j) Use a variety of strategies to listen actively.
k) Summarize and evaluate information presented orally by others.
l) Assume shared responsibility for collaborative work.

9.2 The student will produce, analyze, and evaluate auditory, visual, and written media messages.

a) Analyze and interpret special effects used in media messages including television, film, and Internet.
b) Determine the purpose of the media message and its effect on the audience.
c) Describe possible cause-effect relationships between mass media coverage and public opinion trends.
d) Evaluate sources including advertisements, editorial, and feature stories for relationships between intent and factual content.
e) Monitor, analyze, and use multiple streams of simultaneous information.

Reading ~~Analysis~~

~~9.3 The student will read and analyze a variety of literature.~~

a) ~~Identify format, text structure, and main idea.~~ [Moved to SOL 9.4a]
b) ~~Identify the characteristics that distinguish literary forms~~. [Moved to SOL 9.4b]
c) ~~Use literary terms in describing and analyzing selections.~~ [Moved to SOL 9.4c]
d) ~~Explain the relationships between and among elements of literature: characters, plot, setting, tone, point of view, and theme~~. [Moved to SOL 9.4d]
e) ~~Explain the relationship between the author's style and literary effect.~~ [Moved to SOL 9.4g]
f) ~~Describe the use of images and sounds to elicit the reader's emotions.~~
g) ~~Explain the influence of historical context on the form, style, and point of view of a written work.~~ [Moved to SOL 9.4h]

9.3 The student will apply knowledge of word origins, derivations, and figurative language to extend vocabulary development in authentic texts.

a) Use structural analysis of roots, affixes, synonyms, antonyms, and cognates to understand complex words.
b) Use context, structure, and connotations to determine meanings of words and phrases.
c) Discriminate between connotative and denotative meanings and interpret the connotative power of words.
d) Identify the meaning of common idioms.
e) Identify literary and classical allusions and figurative language in text.
f) Extend general and specialized vocabulary through speaking, reading, and writing.
g) Use knowledge of the evolution, diversity, and effects of language to comprehend and elaborate the meaning of texts.

~~9.4 The student will read and analyze a variety of informational materials (manuals, textbooks, business letters, newspapers, brochures, reports, catalogs) and nonfiction materials, including journals, essays, speeches, biographies, and autobiographies~~. [Moved to SOL 9.5]

a) ~~Identify a position/argument to be confirmed, disproved, or modified~~. [Moved to SOL 9.5d]
b) ~~Evaluate clarity and accuracy of information.~~ [Moved to SOL 9.5e]
c) ~~Synthesize information from sources and apply it in written and oral presentations.~~ [Moved to SOL 9.5i]
d) ~~Identify questions not answered by a selected text.~~
e) ~~Extend general and specialized vocabulary through speaking, reading, and writing.~~
f) ~~Read and follow instructions to complete an assigned project or task.~~ [Moved to SOL 9.5j]

9.4 The student will read, comprehend, and analyze a variety of literary texts including narratives, narrative nonfiction, poetry, and drama.

a) Identify author's main idea and purpose.
b) Summarize text relating supporting details.
c) Identify the characteristics that distinguish literary forms.
d) Use literary terms in describing and analyzing selections.
e) Explain the relationships between and among elements of literature: characters, plot, setting, tone, point of view, and theme.
f) Compare and contrast the use of rhyme, rhythm, sound, imagery, and other literary devices to convey a message and elicit the reader's emotion.
g) Analyze the cultural or social function of a literary text.
h) Explain the relationship between the author's style and literary effect.
i) Explain the influence of historical context on the form, style, and point of view of a written work.
j) Compare and contrast author's use of literacy elements within a variety of genres.
k) Analyze how an author's specific word choices and syntax achieve special effects and support the author's purpose.
l) Make predictions, inferences, draw conclusions, and connect prior knowledge to support reading comprehension.
m) Use reading strategies to monitor comprehension throughout the reading process.

~~9.5~~ ~~The student will read dramatic selections.~~ [Moved to SOL 9.4]

a) ~~Identify the two basic parts of drama: staging and scripting.~~
b) ~~Compare and contrast the elements of character, setting, and plot in one-act plays and full-length plays.~~
c) ~~Describe how stage directions help the reader understand a play's setting, mood, characters, plot, and theme.~~

9.5 The student will read and analyze a variety of nonfictional texts.

a) Recognize an author's intended purpose for writing and identify the main idea.
b) Summarize text relating supporting details.
c) Understand the purpose of text structures and use those features to locate information and gain meaning from texts.
d) Identify characteristics of expository, technical, and persuasive texts.
e) Identify a position/argument to be confirmed, disproved, or modified.
f) Evaluate clarity and accuracy of information.
g) Analyze and synthesize information in order to solve problems, answer questions or complete a task.
h) Draw conclusions and make inferences on explicit and implied information using textural support as evidence.
i) Differentiate between fact and opinion.
j) Organize and synthesize information from sources for use in written and oral presentations.
k) Use the reading strategies to monitor comprehension throughout the reading process.

Writing

9.6 The student will develop narrative, expository, ~~informational,~~ and persuasive writings ~~to inform, explain, analyze, or entertain~~ for a variety of audiences and purposes.

a) Generate, gather, and organize ideas for writing.
b) Plan and organize writing to address a specific audience and purpose.
c) Communicate clearly the purpose of the writing using a thesis statement where appropriate.
d) Write clear, varied sentences using specific vocabulary and information.
e) Elaborate ideas clearly through word choice and vivid description. ~~Use specific vocabulary and information~~. [Moved to SOL 9.6d]
f) Arrange paragraphs into a logical progression.
g) Use transitions between paragraphs and ideas. ~~Revise writing for clarity~~. [Moved to SOL 9.6h]
h) Revise writing for clarity of content, accuracy and depth of information. ~~Proofread and prepare final product for intended audience and purpose~~ [Moved to SOL 9.6i]
i) Use computer technology to plan, draft, revise, edit and publish writing.

9.7 The student will self- and peer-edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure, and paragraphing.

a) Use and apply rules for the parts of a sentence, including subject/verb, direct/indirect object, and predicate nominative/predicate adjective, and coordinating conjunctions.
b) Use parallel structures across sentences and paragraphs.
c) Use appositives, main clauses, and subordinate clauses.
d) Use commas and semicolons to distinguish and divide main and subordinate clauses.
e) Distinguish between active and passive voice.
f) Proofread and edit writing for intended audience and purpose.

Research

9.8 The student will use print, electronic databases, online resources, and other media to access information to create a research product ~~credit the sources of both quoted and paraphrased ideas~~. [Moved to SOL 9.8f]

a) Use technology as a tool for research to organize, evaluate, and communicate information. ~~Define the meaning and consequences of plagiarism.~~ [Moved to SOL 9.8h]
b) Narrow the focus of a search. ~~Distinguish one's own ideas from information created or discovered by others~~. [Moved to SOL 9.8h]
c) Find, evaluate, and select appropriate sources to access information and answer questions. ~~Use a style sheet, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA), for citing sources.~~ [Moved to SOL 9.8g]
d) Verify the validity and accuracy of all information.
e) Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, point of view or bias.
f) Credit the sources of quoted, paraphrased, and summarized ideas.
g) Cite sources of information using a standard method of documentation such as that of the Modern Language Association (MLA) or the American Psychological Association (APA).
h) Define the meaning and consequences of plagiarism following ethical and legal guidelines for gathering and using information.

~~9.9~~ ~~The student will use print, electronic databases, and online resources to access information.~~ [Move to SOL 9.8]

a) ~~Identify key terms specific to research tools and processes.~~
b) ~~Narrow the focus of a search~~. [Moved to SOL 9.8b]
c) ~~Scan and select resources.~~ [Moved to SOL 9.8c]
d) ~~Distinguish between reliable and questionable Internet sources and apply responsible use of technology~~. [Moved to SOL 9.8d]

Grade Ten

The tenth-grade student will become a skilled communicator in small-group learning activities. The student will examine, analyze and produce media messages. The student will continue development of vocabulary, with attention to connotations, idioms, allusions, and evolution of language. The student will read and ~~critique~~ analyze literary ~~works~~ texts from a variety of eras and cultures. Attention will be given to the analysis of ~~consumer information, such as labels, owners' manuals, warranties, and contracts~~ nonfictional texts. The student will critique the writing of peers and professionals, using analysis to improve writing skills. The student will continue to build research skills by crediting sources and presenting information in a format appropriate for content. Grammar knowledge will be expanded as the student presents, writes, and edits materials, applying the conventions of language.
The bodies of literature for grades 10, 11, and 12 are interchangeable and may be taught in any of these grades.

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

10.1 The student will participate in, collaborate in, and report on small-group learning activities.

a) Assume responsibility for specific group tasks.
b) ~~Participate~~ Collaborate in the preparation ~~of an outline~~ or summary of the group activity.
c) Include all group members in oral presentation.
d) ~~Use grammatically correct language, including~~ Choose vocabulary, language, and tone appropriate to the topic, audience, and purpose.
e) Demonstrate the ability to work effectively with diverse teams to accomplish a common goal.
f) Collaborate with others to exchange ideas, develop new understandings, make decisions, and solve problems.
g) Access and critically evaluate information and use information accurately to solve problems.
h) Evaluate one's own role in preparation and delivery of oral reports.
i) Use a variety of strategies to listen actively.
j) Analyze and interpret other's presentations.
k) Evaluate effectiveness of group process in preparation and delivery of oral reports.

~~10.2~~ ~~The student will critique oral reports of small-group learning activities.~~ [Moved to SOL 10.1]

a) ~~Evaluate one's own role in preparation and delivery of oral reports.~~ [Moved to SOL 10.1h]
b) ~~Evaluate effectiveness of group process in preparation and delivery of oral reports.~~ [Moved to SOL 10.1j]

10.2 The student will analyze, produce, and examine similarities and differences between visual and verbal media messages.

a) Use media, visual literacy, and technology skills to create products.
b) Evaluate sources including advertisements, editorials, blogs, Web sites, and other media for relationships between intent, factual content, and opinion.
c) Determine the author's purpose and intended effect on the audience for media messages.
d) Identify the tools and techniques used to achieve the intended focus.

Reading ~~Analysis~~

~~10.3~~ ~~The student will read, comprehend, and critique literary works.~~[Moved to SOL 10.4]

a) ~~Identify text organization and structure.~~
b) ~~Identify main and supporting ideas.~~
c) ~~Make predictions, draw inferences, and connect prior knowledge to support reading comprehension.~~
d) ~~Explain similarities and differences of techniques and literary forms represented in the literature of different cultures and eras.~~
e) ~~Identify universal themes prevalent in the literature of different cultures.~~
f) ~~Examine a literary selection from several critical perspectives.~~

10.3 The student will apply knowledge of word origins, derivations, and figurative language to extend vocabulary development in authentic texts.

a) Use structural analysis of roots, affixes, synonyms, antonyms, and cognates to understand complex words.
b) Use context, structure, and connotations to determine meanings of words and phrases.
c) Discriminate between connotative and denotative meanings and interpret the connotative power of words.
d) Identify the meaning of common idioms.
e) Identify literary and classical allusions and figurative language in text.
f) Extend general and specialized vocabulary through speaking, reading, and writing.
g) Use knowledge of the evolution, diversity, and effects of language to comprehend and elaborate the meaning of texts.

~~10.4~~ ~~The student will read and interpret informational materials.~~ [Moved to SOL 10.5]

a) ~~Analyze and apply the information contained in warranties, contracts, job descriptions, technical descriptions, and other informational sources, including labels, warnings, manuals, directions, applications, and forms, to complete specific tasks.~~
b) ~~Skim manuals or informational sources to locate information.~~
c) ~~Compare and contrast product information contained in advertisements with that found in instruction manuals and warranties.~~

10.4 The student will read, comprehend, and analyze literary texts of different cultures and eras.

a) Identify main and supporting ideas.
b) Make predictions, draw inferences, and connect prior knowledge to support reading comprehension.
c) Explain similarities and differences of techniques and literary forms represented in the literature of different cultures and eras.
d) Analyze the cultural or social function of literature.
e) Identify universal themes prevalent in the literature of different cultures.
f) Examine a literary selection from several critical perspectives.
g) Explain the influence of historical context on the form, style, and point of view of a literary text.
h) Evaluate how an author's specific word choices, syntax, tone, and voice shape the intended meaning of the text, achieve specific effects and support the author's purpose.
i) Compare and contrast literature from different cultures and eras.
j) Distinguish between a critique and a summary.
k) Compare and contrast how rhyme, rhythm, sound, imagery, style, form, and other literary devices convey a message and elicit a reader's emotions.
l) Compare and contrast character development in a play to characterization in other literary forms.
m) Use reading strategies to monitor comprehension throughout the reading process.

~~10.5~~ ~~The student will read and analyze a variety of poetry.~~ [Moved to SOL 10.4]

a) ~~Compare and contrast the use of rhyme, rhythm, and sound to convey a message.~~
b) ~~Compare and contrast the ways in which poets use techniques to evoke emotion in the reader.~~
c) ~~Interpret and paraphrase the meaning of selected poems.~~

10.5 The student will read, interpret, analyze, and evaluate nonfictional texts.

a) Identify text organization and structure.
b) Recognize an author's intended audience and purpose for writing.
c) Skim manuals or informational sources to locate information.
d) Compare and contrast informational texts.
e) Interpret and use data and information in maps, charts, graphs, timelines, table and diagrams.
f) Draw conclusions and make inferences on explicit and implied information using textural support as evidence.
g) Analyze and synthesize information in order to solve problems, answer questions, and generate new knowledge.
h) Use reading strategies throughout the reading process to monitor comprehension.

~~10.6~~ ~~The student will read and critique dramatic selections.~~ [Moved to SOL 10.4]

a) ~~Explain the use of asides, soliloquies, and monologues in the development of a single character.~~
b) ~~Compare and contrast character development in a play to characterization in other literary forms.~~

Writing

~~10.7~~ 10.6 The student will develop a variety of writing to persuade, interpret, analyze, and evaluate with an emphasis on exposition and analysis.

a) Generate, gather, plan, and organize ideas for writing to address a specific audience and purpose.
b) Synthesize information to support the thesis. ~~Elaborate ideas clearly through word choice and vivid description~~. [Moved to SOL 10.6c]
c) Elaborate ideas clearly through word choice and vivid description. ~~Write clear and varied sentences.~~ [Moved to SOL 10.6d]
d) Write clear and varied sentences, clarifying ideas with precise and relevant evidence.~~-Organize ideas into a logical sequence~~. [Moved to SOL 10.6e]
e) Organize ideas into a logical sequence using transitions. ~~Revise writing for clarity of content and presentation~~. [Moved to SOL 10.6f]
f) Revise writing for clarity of content, accuracy, and depth of information. ~~Proofread and prepare final product for intended audience and purpose.~~ [Moved to SOL 10.7h]
g) Use computer technology to plan, draft, revise, edit, and publish writing.

~~10.8~~10.7 The student will self- and peer-edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure, and paragraphing.

a) Distinguish between active and passive voice. ~~Use a style manual, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA), to apply rules for punctuation and formatting of direct quotations~~. [Moved to SOL 10.7c]
b) Apply rules governing use of the colon.
c) Use a style manual, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA), to apply rules for punctuation and formatting of direct quotations. ~~Distinguish between active and passive voice.~~ [Moved to SOL 10.7a]
d) Differentiate between in-text citations and works cited on the bibliography page.
e) Analyze the writing of others.
f) Describe how the author accomplishes the intended purpose of a piece of writing.
g) Suggest how writing might be improved.
h) Proofread and edit final product for intended audience and purpose.

~~10.9~~ ~~The student will critique professional and peer writing.~~ [Moved to SOL 10.7]

a) ~~Analyze the writing of others.~~ [Moved to SOL 10.7e]
b) ~~Describe how the author accomplishes the intended purpose of a writing.~~ [Moved to SOL 10.7f]
c) ~~Suggest how writing might be improved.~~ [Moved to SOL 10.7g]

~~10.10~~ ~~The student will use writing to interpret, analyze, and evaluate ideas.~~ [Moved to 10.7]

a) ~~Explain concepts contained in literature and other disciplines.~~
b) ~~Translate concepts into simpler or more easily understood terms.~~

Research

~~10.11~~ 10.8 The student will collect, evaluate, organize, and present information to create a research product.

a) Use technology as a tool to research, organize, evaluate, synthesize, and communicate information. ~~Organize information from a variety of sources~~.
b) Develop the central idea or focus.
c) Verify the accuracy, validity, and usefulness of information.
d) Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, point of view or bias. ~~Credit sources for both quoted and paraphrased ideas~~. [Moved to SOL 10.8e]
e) Cite sources for both quoted and paraphrased ideas using a standard method of documentation, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA). ~~Present information in an appropriate format, such as an oral presentation, written report, or visual product~~.
f) Define the meaning and consequences of plagiarism following ethical and legal guidelines for gathering and using information. ~~Use technology to access information, organize ideas, and develop writing~~. [Moved to SOL 10.8a]

Grade Eleven

The eleventh-grade student will be able to make and analyze informative and persuasive oral presentations, with attention to the accuracy of evidence and the effectiveness of delivery. An examination of how media influences beliefs and behaviors will be introduced. The student will continue to develop and expand vocabulary. The study of both classic and contemporary American literature will enhance the student's appreciation for literature. The student will be able to identify the prevalent themes and characterizations present in American literature, which are reflective of the history and culture. Students will also use nonfiction texts to draw conclusions and make inferences citing textural support. The student will be able to write clear and accurate personal, professional, and informational correspondence and reports for research and other applications. Grammar development will continue through the application of rules for sentence formation, usage, spelling, and mechanics. The student will develop informative and persuasive ~~compositions~~ writings by locating, evaluating, synthesizing, and ~~citing~~ documenting ~~applicable~~ information ~~with careful attention to organization and accuracy~~ following ethical and legal guidelines.
* The bodies of literature for grades 10, 11, and 12 are interchangeable and may be taught in any of these grades.*

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

11.1 The student will make informative and persuasive presentations.
- a) Gather and organize evidence to support a position.
- b) Present evidence clearly and convincingly.
- c) Address counterclaims. ~~Support and defend ideas in public forums~~. [Moved to SOL 11.1d]
- d) Support and defend ideas in public forums. ~~Use grammatically correct language, including vocabulary appropriate to the topic, audience, and purpose.~~ [Moved to SOL 11.1e]
- e) Use grammatically correct language, including vocabulary appropriate to the topic, audience, and purpose.
- f) Monitor listening and use a variety of active listening strategies to make evaluations.
- g) Use presentation technology.
- h) Collaborate and report on small-group learning activities.

~~11.2~~ ~~The student will analyze and evaluate informative and persuasive presentations.~~
- ~~a) Critique the accuracy, relevance, and organization of evidence.~~
- ~~b) Critique the clarity and effectiveness of delivery.~~

11.2 The student will examine how values and points of view are included or excluded and how media influences beliefs and behaviors.
- a) Use technology and other information tools to organize and display knowledge in ways others can view, use, and assess.
- b) Use media, visual literacy, and technology skills to create products.
- c) Evaluate sources including advertisements, editorials, blogs, Web sites, and other media for relationships between intent, factual content, and opinion.
- d) Determine the author's purpose and intended effect on the audience for media messages.

Reading ~~Analysis~~

~~11.3~~ ~~The student will read and analyze relationships among American literature, history, and culture.~~ [Moved to SOL 11.4]

a) ~~Describe contributions of different cultures to the development of American literature.~~
b) ~~Compare and contrast the development of American literature in its historical context.~~
c) ~~Discuss American literature as it reflects traditional and contemporary themes, motifs, universal characters, and genres.~~
d) ~~Describe how use of context and language structures conveys an author's intent and viewpoint in contemporary and historical essays, speeches, and critical reviews.~~

11.3 The student will apply knowledge of word origins, derivations, and figurative language to extend vocabulary development in authentic texts.

a) Use structural analysis of roots, affixes, synonyms, antonyms, and cognates to understand complex words.
b) Use context, structure, and connotations to determine meanings of words and phrases.
c) Discriminate between connotative and denotative meanings and interpret the connotative power of words.
d) Identify the meaning of common idioms.
e) Identify literary and classical allusions and figurative language in text.
f) Extend general and specialized vocabulary through speaking, reading, and writing.
g) Use knowledge of the evolution, diversity, and effects of language to comprehend and elaborate the meaning of texts.

~~11.4~~ ~~The student will read and analyze a variety of informational materials.~~ [Moved to SOL 11.5]

a) ~~Use information from texts to clarify or refine understanding of academic concepts.~~
b) ~~Read and follow directions to complete an application for college admission, for a scholarship, or for employment.~~
c) ~~Apply concepts and use vocabulary in informational and technical materials to complete a task.~~
d) ~~Generalize ideas from selections to make predictions about other texts.~~
e) ~~Analyze information from a text to draw conclusions.~~

11.4 The student will read, comprehend, and analyze relationships among American literature, history, and culture.

a) Describe contributions of different cultures to the development of American literature.
b) Compare and contrast the development of American literature in its historical context.
c) Discuss American literature as it reflects traditional and contemporary themes, motifs, universal characters, and genres.
d) Analyze the social or cultural function of American literature.
e) Analyze how context and language structures convey an author's intent and viewpoint.
f) Explain how the sound of a poem (rhyme, rhythm, onomatopoeia, repetition, alliteration, assonance, and parallelism) supports the subject, mood, and theme.
g) Explain how imagery and figures of speech appeal to the reader's senses and experience.
h) Explain how an author's specific word choices, syntax, tone, and voice support the author's purpose.
i) Read and analyze a variety of American dramatic selections.
j) Analyze the use of literary elements and dramatic conventions including verbal, situational and dramatic irony used in American literature.
k) Generate and respond logically to literal, inferential, evaluative, synthesizing, and critical thinking questions before, during, and after reading texts.

~~11.5~~ ~~The student will read and critique a variety of poetry.~~ [Moved to SOL 11.4]

a) ~~Analyze the poetic elements of contemporary and traditional poems.~~
b) ~~Identify the poetic elements and techniques that are most appealing and that make poetry enjoyable.~~
c) ~~Compare and contrast the works of contemporary and past American poets.~~

11.5 The student will read and analyze a variety of nonfictional texts.

a) Use information from texts to clarify understanding of concepts.
b) Read and follow directions to complete an application for college admission, for a scholarship, or for employment.
c) Generalize ideas from selections to make predictions about other texts.
d) Draw conclusions and make inferences on explicit and implied information using textural support.
e) Analyze two or more texts addressing the same topic to identify authors' purpose and determine how authors reach similar or different conclusions.
f) Identify false premises in persuasive writing.
g) Recognize and analyze use of ambiguity, contradiction, paradox, irony, overstatement, and understatement in text.
h) Generate and respond logically to literal, inferential, evaluative, synthesizing, and critical thinking questions before, during, and after reading texts.

~~11.6~~ ~~The student will read and critique a variety of dramatic selections.~~ [Moved to SOL 11.4]

a) ~~Describe the dramatic conventions or devices used by playwrights to present ideas.~~
b) ~~Compare and evaluate adaptations and interpretations of a script for stage, film, or television.~~
c) ~~Explain the use of verbal, situational, and dramatic irony.~~

Writing

~~11.7~~ 11.6 The student will write in a variety of forms, with an emphasis on persuasion.

a) Generate, gather, plan, and organize ideas for writing to address a specific audience and purpose.
b) Produce arguments in writing that develop a thesis that demonstrates knowledgeable judgments, addresses counterclaims, and provides effective conclusions. ~~Develop a focus for writing.~~
c) Organize ideas in a sustained and logical manner. ~~Evaluate and cite applicable information~~. [Moved to SOL 11.7a]
d) Clarify and defend position with precise and relevant evidence elaborating ideas clearly and accurately. ~~Organize ideas in a logical manner~~. [Moved to SOL 11.6c]
e) Adapt content, vocabulary, voice and tone to audience, purpose, and situation. ~~Elaborate ideas clearly and accurately.~~ [Moved to SOL 11.6d]
f) Revise writing for clarity of content, accuracy and depth of information. ~~Adapt content, vocabulary, voice, and tone to audience, purpose, and situation.~~ [Moved to SOL 11.6e]
g) Use computer technology to plan, draft, revise, edit, and publish writing. ~~Revise writing for accuracy and depth of information.~~ [Moved to SOL 11.6f]
h) Write and revise correspondence to a standard acceptable both in the workplace and in postsecondary education. ~~Proofread final copy and prepare document for intended audience and purpose~~. [Moved to SOL 11.7f]

~~11.8~~ 11.7 The student will self- and peer-edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure, and paragraphing.

a) Use a style manual, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA), to apply rules for punctuation and formatting of direct quotations. ~~Use a style manual, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA), for producing research projects.~~ [Moved to SOL 11.8]
b) Use verbals and verbal phrases to achieve sentence conciseness and variety.
c) Distinguish between active and passive voice. ~~Adjust sentence and paragraph structures for a variety of purposes and audiences.~~ [Moved to SOL 11.7e]
d) Differentiate between in-text citations and works cited on the bibliography page.
e) Adjust sentence and paragraph structures for a variety of purposes and audiences.
f) Proofread and edit writing for intended audience and purpose.

~~11.9~~ ~~The student will write, revise, and edit personal, professional, and informational correspondence to a standard acceptable in the workplace and higher education.~~ [Moved to 11.7]

a) ~~Apply a variety of planning strategies to generate and organize ideas.~~
b) ~~Organize information to support purpose and form of writing.~~
c) ~~Present information in a logical manner.~~
d) ~~Revise writing for clarity.~~
e) ~~Use technology to access information, organize ideas, and develop writing.~~

Research

~~11.10~~ 11.8 The student will analyze, evaluate, synthesize, and organize information from a variety of sources to produce a research product.

a) Use technology as a tool to research, organize, evaluate and communicate information. ~~Narrow a topic.~~ [Moved to SOL 11.8b]
b) Narrow a topic and ~~D~~develop a plan for research.
c) Collect information to support a thesis.
d) Critically evaluate quality, ~~and~~ accuracy, and validity of information.
e) Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, point of view or bias. ~~Synthesize information in a logical sequence~~. [Moved to SOL 11.8f]
f) Synthesize and present information in a logical sequence. ~~Document sources of information, using a style sheet, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA).~~ [Moved to SOL 11.8g]
g) Cite sources for both quoted and paraphrased ideas using a standard method of documentation, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA). ~~Edit writing for clarity of content and effect.~~ [Moved to 11.8h]
h) Revise writing for clarity of content, accuracy, and depth of information. ~~Edit copy for grammatically correct use of language, spelling, punctuation, and capitalization.~~ [Moved to SOL 11.8i]
i) Edit writing for grammatically correct use of language, spelling, punctuation, capitalization, and sentence/paragraph structure. ~~Proofread final copy and prepare document for publication or submission~~.
j) Define the meaning and consequences of plagiarism following ethical and legal guidelines for gathering and using information. ~~Use technology to access information, organize ideas, and develop writing.~~

Grade Twelve

The twelfth-grade student will use organizational skills~~, audience awareness, appropriate vocabulary and grammar,~~ and both verbal and nonverbal presentation skills to plan and deliver an effective ~~5 to 10 minute~~ oral presentation, choosing language and tone appropriate to the audience and purpose. Students will use technology and understanding of media to create, organize, and display knowledge in ways others can access, view, and use. The student will expand general and specialized vocabulary through speaking, listening, reading, and viewing. The student will analyze British literature and literature of other cultures, ~~with attention to the many classic works which may be studied~~ recognizing major literary forms and their elements. Using nonfictional texts, students will analyze and synthesize information to solve problems. Writing will include the production of informational, ~~and~~ expository, and persuasive/argumentative papers, ~~which are organized~~ logically organized demonstrating knowledgeable judgments and effective conclusions ~~and contain clear and accurate ideas~~. The student will also produce a well-documented major research ~~paper~~ product, ~~using a standard method of documentation~~ by locating, evaluating, synthesizing, and documenting information following ethical and legal guidelines. The student will demonstrate advanced knowledge of grammatical conventions through writing, editing, and speaking.
The bodies of literature for grades 10, 11, and 12 are interchangeable and may be taught in any of these grades.

~~Oral Language~~ Communication: Speaking, Listening, Media Literacy

12.1 The student will make a ~~5 to 10 minute~~ [Move to Curriculum Framework] formal oral presentation in a group or individually.

a) Choose the purpose of the presentation ~~to defend a position, to entertain an audience, or to explain information~~.
b) Choose vocabulary, language, and tone appropriate to the audience, topic, and purpose. ~~Use a well-structured narrative or logical argument.~~
c) Use details, illustrations, statistics, comparisons, and analogies to support ~~purposes~~ the presentation.
d) Use media, visual literacy, and technology skills to create and support the presentation.- ~~Use visual aids or technology to support presentation~~
e) Use grammatically correct language, including vocabulary appropriate to the topic, audience, and purpose.
f) Collaborate and report on small group learning activities.
g) Evaluate formal presentations including personal, digital, visual textural, and technological.
h) Use a variety of listening strategies to analyze relationships among purpose, audience, and content of presentations.
i) Critique effectiveness of presentations.

~~12.2~~ ~~The student will evaluate formal presentations.~~ [Moved to SOL 12.1f]

a) ~~Critique relationships among purpose, audience, and content of presentations.~~ [Moved to SOL 12.1g]
b) ~~Critique effectiveness of presentations.~~ [Moved to SOL 12.1h]

12.2 The student will examine how values and points of view are included or excluded and how media influences beliefs and behaviors.

a) Evaluate sources including advertisements, editorials, blogs, Web sites, and other media for relationships between intent, factual content, and opinion.
b) Determine the author's purpose and intended effect on the audience for media messages.

Reading ~~Analysis~~

~~12.3~~ ~~The student will read and analyze the development of British literature and literature of other cultures.~~ [Moved to SOL 12.4]

a) ~~Recognize major literary forms and their elements.~~
b) ~~Recognize the characteristics of major chronological eras.~~
c) ~~Relate literary works and authors to major themes and issues of their eras~~.

12.3 The student will apply knowledge of word origins, derivations, and figurative language to extend vocabulary development in authentic texts.

a) Use structural analysis of roots, affixes, synonyms, antonyms, and cognates to understand complex words.
b) Use context, structure, and connotations to determine meanings of words and phrases.
c) Discriminate between connotative and denotative meanings and interpret the connotative power of words.
d) Identify the meaning of common idioms, literary and classical allusions in text.
e) Expand general and specialized vocabulary through speaking, reading, and writing.
f) Use knowledge of the evolution, diversity, and effects of language to comprehend and elaborate the meaning of texts.

~~12.4~~ ~~The student will read and analyze a variety of informational materials, including electronic resources.~~ [Moved to SOL 12.5]

a) ~~Identify formats common to new publications and information resources.~~
b) ~~Recognize and apply specialized informational vocabulary.~~
c) ~~Evaluate a product based on analysis of the accompanying warranty and instruction manual.~~
d) ~~Evaluate the quality of informational and technical materials.~~

12.4 The student will read, comprehend, and analyze the development of British literature and literature of other cultures.

a) Compare and contrast the development of British literature in its historical context.
b) Recognize major literary forms and their elements.
c) Recognize the characteristics of major chronological eras.
d) Relate literary works and authors to major themes and issues of their eras.
e) Analyze the social and cultural function of British literature.
f) Explain how the sound of a poem (rhyme, rhythm, onomatopoeia, repetition, alliteration, assonance, and parallelism) supports the subject, mood, and theme.
g) Compare and contrast traditional and contemporary poems from many cultures.
h) Analyze how dramatic conventions including character, scene, dialogue, and staging contribute to the theme and effect.
i) Compare and contrast dramatic elements of plays from American, British, and other cultures.

~~12.5~~ ~~The student will read and critique a variety of poetry.~~ [Moved to SOL 12.4]

a) ~~Explain how the choice of words in a poem creates tone and voice.~~
b) ~~Explain how the sound of a poem (rhyme, rhythm, onomatopoeia, repetition, alliteration, assonance, and parallelism) supports the subject and mood.~~
c) ~~Explain how imagery and figures of speech (personification, simile, metaphor) appeal to the reader's senses and experience.~~
d) ~~Compare and contrast traditional and contemporary works of poets from many cultures.~~

12.5 The student will read and analyze a variety of nonfictional texts.

a) Generate and respond logically to literal, inferential, evaluative, synthesizing, and critical thinking questions before, during, and after reading texts.
b) Analyze and synthesize information in order to solve problems, answer questions, and generate new knowledge.
c) Analyze two or more texts addressing the same topic to identify authors' purpose and determine how authors reach similar or different conclusions.
d) Recognize and analyze use of ambiguity, contradiction, paradox, irony, overstatement, and understatement in text.
e) Identify false premises in persuasive writing.
f) Draw conclusions and make inferences on explicit and implied information using textural support.

~~12.6~~ ~~The student will read and critique dramatic selections from a variety of authors.~~

a) ~~Describe the conflict, plot, climax, and setting.~~ [Moved to SOL 12.4]
b) ~~Compare and contrast ways in which character, scene, dialogue, and staging contribute to the theme and the dramatic effect.~~
c) ~~Identify the most effective elements of selected plays.~~
d) ~~Compare and contrast dramatic elements of plays from American, British, and other cultures.~~

Writing

~~12.7~~ 12.6 The student will develop expository and informational, analyses, and persuasive/argumentative writings.

a) Generate, gather, and organize ideas for writing to address a specific audience and purpose.
b) Produce arguments in writing that develop a thesis that demonstrates knowledgeable judgments, addresses counterclaims, and provides effective conclusions. ~~Consider audience and purpose when planning for writing~~. [Moved to SOL 12.6a and SOL 12.6d]
c) Clarify and defend position with precise and relevant evidence. ~~Write analytically about literary, informational, and visual materials.~~
d) Adapt content, vocabulary, voice, and tone to audience, purpose, and situation. ~~Elaborate ideas clearly and accurately.~~ [Moved to SOL 12.6c]
e) Use a variety of rhetorical strategies to accomplish a specific purpose. ~~Revise writing for depth of information and technique of presentation.~~ [Moved to SOL 12.6g]
f) Create arguments free of errors in logic and externally supported. ~~Apply grammatical conventions to edit writing for correct use of language, spelling, punctuation, and capitalization.~~ [Moved to SOL 12.7b]
g) Revise writing for clarity of content, depth of information and technique of presentation. ~~Proofread final copy and prepare document for publication or submission~~. [Moved to SOL 12.7]
h) Use computer technology to plan, draft, revise, edit, and publish writing.

12.7 The student will write, revise, and edit writing.

a) Edit, proofread, and prepare writing for intended audience and purpose.
b) Apply grammatical conventions to edit writing for correct use of language, spelling, punctuation, and capitalization.
c) Use a style manual, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA), to apply rules for punctuation and formatting of direct quotations.

Research

12.8 The student will write documented research papers.

a) Use technology as a tool to research, organize, evaluate, and communicate information. ~~Identify and understand the ethical issues of research and documentation~~. [Moved to SOL 12.8h]
b) Frame, analyze, and synthesize information to solve problems, answer questions, and generate new knowledge. ~~Evaluate the accuracy and usefulness of information~~. [Moved to SOL 12.8c]
c) Critically evaluate the accuracy, quality, and validity of the information. ~~Synthesize information to support the thesis~~. [Moved to SOL 12.8d]
d) Synthesize information to support the thesis and ~~P~~present information in a logical manner.
e) Cite sources ~~of information,~~ for both quoted and paraphrased ideas using a standard method of documentation, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA).
f) Revise writing for clarity, depth of information, and technique of presentation. ~~Edit copies for correct use of language, spelling, punctuation, and capitalization~~. [Moved to SOL 12.8f]
g) Edit writing for language, spelling, punctuation, capitalization, syntax, and paragraphing as appropriate for standard English. ~~Proofread final copy and prepare document for publication or submission.~~
h) Define the meaning and consequences of plagiarism following ethical and legal guidelines for gathering and using information.

Board of Education Agenda Item

Item: J. **Date:** October 22, 2009

Topic: First Review of Proposed Revised *Science Standards of Learning*

Presenter: Ms. Paula Klonowski, Science Coordinator

Telephone Number: (804) 371-0249 **E-Mail Address:** Paula.Klonowski@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

____ Action requested at this meeting _X_ Action requested at future meeting: After public comment

Previous Review/Action:

____ No previous board review/action

_X_ Previous review/action
Date January 15, 2009
Action Board of Education approved the timeline to proceed with the review process.

Background Information:
The Standards of Learning for science were developed in 1995 and revised in 2003. The *Standards of Quality* require the Board of Education to review the Standards of Learning on a regular schedule. The *Science Standards of Learning* are scheduled for review in 2010. As a result, on January 15, 2009, the Board approved a plan to review these standards beginning in 2009. In accordance with the plan, the Department of Education took the following steps to produce a draft of the proposed revised *Science Standards of Learning* for the Board's first review:

- Received online comments from stakeholders, including teachers, parents, and administrators that are summarized in Attachment A;
- Met with a teacher review committee that consisted of recommended individuals solicited from school divisions on July 16 and 17, 2009, to review the public comment and consider recommendations and documents from the: 1) National Assessment of Educational Progress (NAEP) Frameworks; 2) the National Science Education Standards, Benchmarks for Science Literacy; and 3) a report on the 21st century content standards in physics, chemistry and engineering in Virginia's K-12 curriculum prepared by retired staff from the National Aeronautics and Space Administration (NASA) Langley Research Center and presented to Virginia's P-16 Education Council in June 2008 and to the Board of Education as part of public comment in April, May, June, and July 2009.

- Solicited a review committee comprised of faculty from science and science education departments at postsecondary institutions and representatives from state agencies and met with them on August 6, 2009, to review and discuss their comments;
- Solicited a business and industry review committee and met with them on August 17, 2009, to review and discuss their comments; and
- Developed a draft of the proposed revised *Science Standards of Learning*.

Summary of Major Elements:
The attached draft of the proposed revised *Science Standards of Learning* (Attachment B) consists of the following elements:

Introduction
The *Science Standards of Learning* for Virginia's Public Schools identify academic content for essential components of the science curriculum at different grade levels. Standards are identified for kindergarten through grade five, for middle school, and for a core set of high school courses — Earth Science, Biology, Chemistry, and Physics. Throughout a student's science schooling from kindergarten through grade six, content strands, or topics are included. The Standards of Learning in each strand progress in complexity as they are studied at various grade levels in grades K-6, and the strands are represented indirectly throughout the high school courses.

Goals
The purposes of scientific investigation and discovery are to satisfy humankind's quest for knowledge and understanding, to preserve and enhance the quality of the human experience, and to develop an understanding of the interrelationship of science with technology, engineering and mathematics.

K-12 Safety
In implementing the *Science Standards of Learning*, teachers must be certain that students know how to follow safety guidelines, demonstrate appropriate laboratory safety techniques, and use equipment safely while working individually and in groups. Safety must be given the highest priority in implementing the K-12 instructional program for science.

Instructional Technology
The use of current and emerging technologies is essential to the K-12 science instructional program.

Investigate and Understand
Many of the standards in the *Science Standards of Learning* begin with the phrase "Students will investigate and understand." This phrase was chosen to communicate the range of rigorous science skills and knowledge levels embedded in each standard. Limiting a standard to one observable behavior, such as "describe" or "explain," would have narrowed the interpretation of what was intended to be a rich, rigorous, and inclusive content standard.

Application
Science provides the key to understanding the world in which we live. Making connections among science, technology, engineering and mathematics allows us to design and create new devices or materials that increase our efficacy in the world and our enjoyment of it. Various strategies can be used to facilitate applications of science, technology, engineering and mathematics.

Standards

The *Science Standards of Learning* for Virginia public schools describe the Commonwealth's expectations for student learning and achievement in grades K-12. The *Science Standards of Learning* are not intended to encompass the entire science curriculum for a given grade level or course or to prescribe how the content should be taught. Teachers are encouraged to go beyond the standards and to select instructional strategies and assessment methods appropriate for their students.

Summary of the Proposed Revised *Science Standards of Learning*

The major elements of the attached proposed revised *Science Standards of Learning* include:

- Edits to enhance clarity, specificity, rigor, alignment of skills and content, and a reflection of the current academic research and practice;
- The application of science concepts through technology, engineering and mathematics;
- Addition of standards in Kindergarten, Grade Four and Chemistry; and
- Deletion of standards in Life Science, Chemistry and Physics.

Superintendent's Recommendation:

The Superintendent of Public Instruction recommends that the Board of Education accept for first review the proposed revised *Science Standards of Learning*.

Impact on Resources:

This responsibility can be absorbed by the agency's existing resources at this time. If the agency is required to absorb additional responsibilities related to this activity, other services may be impacted.

Timetable for Further Review/Action:

The *Science Standards of Learning* review work plan calls for public comment, public hearings, final review, and adoption of the *Science Standards of Learning* by the Board of Education by winter 2010.

Summary of Online Comments and Review Committees' Comments on Virginia's 2003 *Science Standards of Learning*

A total of 430 comments were received online from individuals and groups for the *Science Standards of Learning* in Kindergarten through Physics during the 30-day public comment period from January 23, 2009, through February 23, 2009.

The number of comments submitted by grade level or course included:

Course	Number of Comments
Kindergarten	27
Grade 1	23
Grade 2	33
Grade 3	41
Grade 4	59
Grade 5	64
Grade 6	18
Life Science	32
Physical Science	23
Earth Science	30
Biology	29
Chemistry	19
Physics	11

There were also 21 general comments made about the K-12 *Science Standards of Learning*.

Groups submitting online comments included:

- Henrico County Public Schools elementary science teachers
- Mathews County Public Schools vertical science team
- Newport News City Public Schools elementary science lead teachers
- Powhatan County Public Schools biology teachers
- Roanoke City Public Schools biology teachers
- Department of Environmental Quality Office of Environmental Education
- James Madison University Center for STEM Education and Outreach
- Science Museum of Virginia
- Virginia Association of Science Teachers (VAST) chemistry committee
- Virginia Science Education Leadership Association (VSELA)

Three review committees met during the summer to review public comment, science reports, and pertinent national documents and to review the *2003 Science Standards of Learning* in order to make recommendations for edits to the *Science Standards of Learning*. These committees were comprised of individuals from school divisions, higher education, state agencies and business and industry. The following is a summary of input from the public online comments and the review committees regarding changes to the *Science Standards of Learning*:

- Clarify what is meant by the nature of science;
- Reorder and add to the Scientific Investigation, Reasoning, and Logic bullets in grades K-5 to provide teachers and students with a logical, coherent and comprehensive set of process skills that are foundational to understanding the nature of science and to conducting investigations;
- Include relevance to everyday life, using experiments and projects that relate science to real-life applications in science instruction, along with critical thinking skills, problem formation techniques, solution development, and abstraction and synthesis of information;
- Include project-based learning, simulation and modeling, and cross-curricular applications in science instruction;
- Apply the scientific process skills to scientific investigations, field investigations, and engineering design projects;
- Introduce the solar system before sixth grade;
- Clarify standards in K-5 dealing with plants and animals to ensure accuracy of information;
- Use consistent terminology and content in vertical alignment of the standards;
- Update standards to include references to additional energy sources;
- Include more emphasis on climate and less on weather in Earth Science, and less focus on geology;
- Move examples and details to the Curriculum Framework;
- Add organic chemistry to the Chemistry standards;
- Reduce the content in the Physics standards; and
- Incorporate nanotechnology into grades 6 through 12.

Attachment B

Proposed Revised Science Standards of Learning

for Virginia Public Schools

First Review

October 22, 2009

Preface

The Standards of Learning in this publication represent a significant development in public education in Virginia. These standards focus on the scientific knowledge and skills all students need for the future, and they have been aligned with national expectations for postsecondary success.

The Standards of Learning provide a framework for instructional programs designed to raise the academic achievement of all students in Virginia and are an important part of Virginia's efforts to provide challenging educational programs in the public schools.

The Standards of Learning set reasonable targets and expectations for what teachers must teach and students must learn. The standards are not intended to encompass the entire curriculum for a given grade level or course or to prescribe how the content should be taught; the standards are to be incorporated into a broader, locally designed curriculum. Teachers are encouraged to go beyond the standards and select instructional strategies and assessment methods appropriate for their students.

The Standards of Learning are recognized as a model for other states. They were developed through a series of public hearings and the efforts of parents, teachers, representatives from higher education, and business and industry leaders. The standards set clear, concise, and measurable academic expectations for young people. Parents are encouraged to work with their children to help them achieve these academic standards.

A major goal of Virginia's educational agenda is to create an excellent statewide system of public education that meets the needs of all young people in Virginia. These Standards of Learning chart the course for achieving that objective.

Introduction

The *Science Standards of Learning* for Virginia~~'s~~ Public Schools identify academic content for essential components of the science curriculum at different grade levels. Standards are identified for kindergarten through grade five, for middle school, and for a core set of high school courses — Earth Science, Biology, Chemistry, and Physics. Throughout a student's science schooling from kindergarten through grade six, ~~specific~~ content strands, or topics are included. The Standards of Learning in each strand progress in complexity as they are studied at various grade levels in grades K-6, and are represented indirectly throughout the high school courses. These strands are

- Scientific Investigation, Reasoning, and Logic;
- Force, Motion, and Energy;
- Matter;
- Life Processes;
- Living Systems;
- Interrelationships in Earth/Space Systems;
- Earth Patterns, Cycles, and Change; and
- Earth Resources.

~~The Standards of Learning in each strand progress in complexity at each grade level K-6 and are represented indirectly throughout the high school courses.~~

~~The Standards of Learning are not intended to encompass the entire science curriculum for a given grade level or course or to prescribe how the content should be taught. Teachers are encouraged to go beyond the standards and to select instructional strategies and assessment methods appropriate for their students.~~
[Moved to preface]

~~Four~~ Five key components of the science standards that are critical to implementation and necessary for student success in achieving science literacy are described below. It is imperative to science instruction that the local curriculum consider and address how these components are incorporated in the design of the kindergarten through high school science program.

Goals

The purposes of scientific investigation and discovery are to satisfy humankind's quest for knowledge and understanding and to preserve and enhance the quality of the human experience. Therefore, as a result of science instruction, students will be able to achieve the following objectives:

1. Develop and use an experimental design in scientific inquiry.
2. Use the language of science to communicate understanding.
3. Investigate phenomena, using technology.
4. Apply scientific concepts, skills, and processes to everyday experiences.
5. Experience the richness and excitement of scientific discovery of the natural world through the collaborative quest for knowledge and understanding.

6. Make informed decisions regarding contemporary issues, taking into account the following:
    - public policy and legislation;
    - economic costs/benefits;
    - validation from scientific data and the use of scientific reasoning and logic;
    - respect for living things;
    - personal responsibility; and
    - history of scientific discovery.
7. Develop scientific dispositions and habits of mind including:
    - curiosity;
    - demand for verification;
    - respect for logic and rational thinking;
    - consideration of premises and consequences;
    - respect for historical contributions;
    - attention to accuracy and precision; and
    - patience and persistence.
8. Develop an understanding of the interrelationship of science with technology, engineering and mathematics.

~~8.~~ 9.Explore science-related careers and interests.

K-12 Safety

In implementing the *Science Standards of Learning*, teachers must be certain that students know how to follow safety guidelines, demonstrate appropriate laboratory safety techniques, and use equipment safely while working individually and in groups.

Safety must be given the highest priority in implementing the K-12 instructional program for science. Correct and safe techniques, as well as wise selection of experiments, resources, materials, and field experiences appropriate to age levels, must be carefully considered with regard to the safety precautions for every instructional activity. Safe science classrooms require thorough planning, careful management, and constant monitoring of student activities. Class enrollment should not exceed the designed capacity of the room.

Teachers must be knowledgeable of the properties, use, and proper disposal of all chemicals that may be judged as hazardous prior to their use in an instructional activity. Such information is referenced through Materials Safety Data Sheets (MSDS). The identified precautions involving the use of goggles, gloves, aprons, and fume hoods must be followed as prescribed.

While no comprehensive list exists to cover all situations, the following should be reviewed to avoid potential safety problems. Appropriate safety procedures should be used in the following situations:

- observing wildlife; handling living and preserved organisms; and coming in contact with natural hazards, such as poison ivy, ticks, mushrooms, insects, spiders, and snakes;
- engaging in field activities in, near, or over bodies of water;
- handling glass tubing and other glassware, sharp objects, and labware;
- handling natural gas burners, Bunsen burners, and other sources of flame/heat;
- working in or with direct sunlight (sunburn and eye damage);
- using extreme temperatures and cryogenic materials;
- handling hazardous chemicals including toxins, carcinogens, and flammable and explosive materials;
- producing acid/base neutralization reactions/dilutions;
- producing toxic gases;
- generating/working with high pressures;
- working with biological cultures including their appropriate disposal and recombinant DNA;
- handling power equipment/motors;
- working with high voltage/exposed wiring; and
- working with laser beam, UV, and other radiation.

The use of human body fluids or tissues is generally prohibited for classroom lab activities. Further guidance from the following sources may be referenced:

- OSHA (Occupational Safety and Health Administration);
- ISEF (International Science and Engineering Fair) rules; and
- public health departments' and school divisions' protocols.

Instructional Technology

The use of current and emerging technologies is essential to the K-12 science instructional program. Specifically, technology must accomplish the following:

- Assist in improving every student's functional literacy. This includes improved communication through reading/information retrieval (the use of telecommunications), writing (word processing), organization and analysis of data (databases, spreadsheets, and graphics programs), presentation of one's ideas (presentation software), and resource management (project management software).
- Be readily available and regularly used as an integral and ongoing part of the delivery and assessment of instruction.
- Include instrumentation oriented toward the instruction and learning of science concepts, skills, and processes. Technology, however, should not be limited to traditional instruments of science, such as microscopes, labware, and data-collecting apparatus, but should also include computers, robotics, ~~interactive-optical laser discs,~~ video-microscopes, graphing calculators, ~~CD-ROMs,~~

probeware, ~~global positioning systems (GPS)~~geospatial technologies, online ~~tele~~communication, software and appropriate hardware, as well as other emerging technologies.

- Be reflected in the "instructional strategies" generally developed at the school division level.

In most cases, the application of technology in science should remain "transparent" unless it is the actual focus of the instruction. One must expect students to "do as a scientist does" and not simply hear about science if they are truly expected to explore, explain, and apply scientific concepts, skills, and processes.

As computer/technology skills are essential components of every student's education, it is important that teaching these skills is a shared responsibility of teachers of all disciplines and grade levels.

Investigate and Understand

Many of the standards in the *Science Standards of Learning* begin with the phrase "Students will investigate and understand." This phrase was chosen to communicate the range of rigorous science skills and knowledge levels embedded in each standard. Limiting a standard to one observable behavior, such as "describe" or "explain," would have narrowed the interpretation of what was intended to be a rich, highly rigorous, and inclusive content standard.

"Investigate" refers to scientific methodology and implies systematic use of the following inquiry skills:

- observing;
- classifying and sequencing;
- communicating;
- measuring;
- predicting;
- hypothesizing;
- inferring;
- defining, controlling, and manipulating variables in experimentation;
- designing, constructing, and interpreting models; and
- interpreting, analyzing, and evaluating data.

"Understand" refers to various levels of knowledge application. In the *Science Standards of Learning*, these knowledge levels include the ability to

- recall or recognize important information, key definitions, terminology, and facts;
- explain the information in one's own words, comprehend how the information is related to other key facts, and suggest additional interpretations of its meaning or importance;
- apply the facts and principles to new problems or situations, recognizing what information is required for a particular situation, using the information to explain new phenomena, and determining when there are exceptions;
- analyze the underlying details of important facts and principles, recognizing the key relations and patterns that are not always readily visible;

- arrange and combine important facts, principles, and other information to produce a new idea, plan, procedure, or product; and
- make judgments about information in terms of its accuracy, precision, consistency, or effectiveness.

Therefore, the use of "investigate and understand" allows each content standard to become the basis for a broad range of teaching objectives, which the school division will develop and refine to meet the intent of the *Science Standards of Learning*.

Application

Science provides the key to understanding the world in which we live. Making connections among science, technology, engineering and mathematics allows us to design and create new devices or materials that increase our efficacy in the world and our enjoyment of it. Various strategies can be used to facilitate applications of science, technology, engineering and mathematics.

Kindergarten

The kindergarten standards stress the use of basic science skills to explore common materials, objects, and living things. Emphasis is placed on using the senses to gather information. Students are expected to develop skills in posing simple questions, measuring, sorting, classifying, and communicating information about the natural world. The science skills are an important focus as students learn about life processes and properties of familiar materials, such as magnets and water. Through phenomena including shadows, patterns of weather, and plant growth, students are introduced to the concept of change. The significance of natural resources and conservation is introduced in the kindergarten standards.

Scientific Investigation, Reasoning, and Logic

K.1 The student will demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

- a) basic ~~properties~~ characteristics of objects are identified by direct observation;
- b) observations are made from multiple positions to achieve different perspectives;
- ~~c) objects are described both pictorially and verbally;~~ [Moved to SOL K.1k]
- ~~d)~~ c) a set of objects is sequenced according to size;
- ~~e)~~ d) a set of objects is separated into two groups based on a single physical ~~attribute~~ characteristic;
- ~~f)~~ e) nonstandard units are used to measure the length, mass, and volume of common objects;
- ~~i)~~ f) observations and predictions are made of an unseen member in a sequence of objects ~~is predicted~~;
- g) a question is developed and predictions are made from one or more observations;
- h) observations are recorded;
- ~~h)~~ i) picture graphs are constructed ~~using 10 or fewer units~~ [Move to Curriculum Framework];
- j) unusual or unexpected results in an activity are recognized~~.~~; and
- ~~c)~~ k) objects are described both pictorially and verbally~~;~~.

K.2 The ~~S~~students will investigate and understand that humans have senses that allow ~~one~~ them to seek, find, take in, and react or respond to information in order to learn about ~~one's~~ their surroundings. Key concepts include

- a) the five senses and corresponding sensing organs ~~(taste – tongue, touch – skin, smell – nose, hearing – ears, and sight – eyes)~~ [Move to Curriculum Framework]; and
- b) sensory descriptors used to describe common objects and phenomena ~~(sweet, sour, bitter, salty, rough/smooth, hard/soft, cold, warm, hot, loud/soft, high/low, bright/dull)~~ [Move to Curriculum Framework].

Force, Motion, and Energy

K.3 The student will investigate and understand that magnets have an effect on some materials, make some things move without touching them, and have useful applications. Key concepts include

- a) ~~attraction/nonattraction, push/pull, attract/repel, and metal/nonmetal~~ [Move to Curriculum Framework] magnetism and its effect; and
- b) useful applications ~~(refrigerator magnet, can opener, magnetized screwdriver, and magnetic games)~~ [Move to Curriculum Framework] of magnetism.

Matter

K.4 The student will investigate and understand that the position, motion, and physical properties of an object can be described. Key concepts include

a) colors ~~(red, orange, yellow, green, blue, purple), white, and black~~ [Move to Curriculum Framework] of objects;

b) shapes ~~(circle, triangle, square, and rectangle)~~ [Move to Curriculum Framework] and forms ~~(flexible/stiff, straight/curved)~~ [Move to Curriculum Framework] of objects;

c) textures ~~(rough/smooth)~~ [Move to Curriculum Framework] and feel ~~(hard/soft)~~ [Move to Curriculum Framework] of objects;

d) relative size and weight ~~(big/little, large/small, heavy/light, wide/thin, long/short)~~ [Move to Curriculum Framework] of objects; and

e) relative position ~~(over/under, in/out, above/below, left/right)~~ [Move to Curriculum Framework] and speed ~~(fast/slow)~~ [Move to Curriculum Framework] of objects.

K.5 The student will investigate and understand that water flows and has properties that can be observed and tested. Key concepts include

a) water occurs in different ~~states~~ phases ~~(solid, liquid, gas)~~ [Move to Curriculum Framework];

b) ~~the natural~~ water tends to flow ~~of water is~~ downhill; and

c) some materials float in water, while others sink.

Life Processes

K.6 The student will investigate and understand the differences between living organisms and nonliving objects. Key concepts include

a) all things can be classified as living or nonliving; and

b) living organisms have certain characteristics that distinguish them from nonliving objects including growth, movement, response to the environment, having offspring, and the need for food, air, and water.

~~K.6~~ K.7 The student will investigate and understand basic needs and life processes of plants and animals. Key concepts include

a) ~~living things change as they grow, and they~~ animals need adequate food, water, shelter, ~~and~~ air, and space to survive;

~~b)~~ ~~plants and animals live and die (go through a life cycle); and~~ [Moved to SOL K.7c]

b) plants need nutrients, water, air, light, and a place to grow to survive;

~~c)~~ ~~offspring of plants and animals are similar but not identical to their parents and to one another.~~ [Moved to SOL K.7d]

~~b)~~ c) plants and animals ~~live and die (go through a~~ change as they grow, and have varied life cycles~~)~~; and

~~c)~~ d) offspring of plants and animals are similar but not identical to their parents and to one another.

Interrelationships in Earth/Space Systems

~~K.7~~ K.8 The student will investigate and understand that shadows occur when light is blocked by an object. Key concepts include

a) shadows occur in nature when sunlight is blocked by an object; and

b) shadows can be produced by blocking artificial light sources.

Earth Patterns, Cycles, and Change

~~K.8~~ K.9 The student will investigate and understand that there are simple repeating patterns in his/her daily life. Key concepts include

a) weather observations;
b) the shapes and forms of many common natural objects including seeds, cones, and leaves; and
c) animal and plant growth~~;~~. ~~and~~
~~d) home and school routines.~~

~~K.9~~ K.10 The student will investigate and understand that change occurs over time and rates may be fast or slow. Key concepts include

a) natural and human-made things may change over time; and
b) changes can be ~~noted~~ observed and measured.

Earth Resources

~~K.10~~ K.11 The student will investigate and understand that materials can be reused, recycled, and conserved. Key concepts include

a) materials and objects can be used over and over again;
b) everyday materials can be recycled; and
c) water and energy conservation at home and in school helps ~~preserve~~ ensure resources are available for future use.

Grade One

The first-grade standards continue to stress basic science skills in understanding familiar objects and events. Students are expected to begin conducting simple experiments and be responsible for some of the planning. Students are introduced to the concept of classifying plants and animals based on simple characteristics. Emphasis is placed on the relationships among objects and their interactions with one another. Students are expected to know the basic relationships between the sun and Earth and between seasonal changes and plant and animal activities. Students will also begin to develop an understanding of moving objects, simple solutions, and important natural resources.

Scientific Investigation, Reasoning, and Logic

1.1 The student will demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

- a) ~~differences in physical properties are observed using~~ the senses are used to observe differences in physical properties;
- ~~b) simple tools are used to enhance observations;~~ [Moved to SOL 1.1d]
- b) observations are made from multiple positions to achieve a variety of perspectives;
- c) objects or events are classified and arranged according to ~~attributes~~ characteristics or properties;
- ~~d) observations and data are communicated orally and with simple graphs, pictures, written statements, and numbers;~~ [Move to SOL 1.1i]
- ~~b)~~ d) simple tools are used to enhance observations;
- e) length, mass, ~~and~~ volume, and temperature are measured using ~~standard and~~ nonstandard units;
- ~~f) predictions are based on patterns of observation rather than random guesses;~~ [Moved to SOL 1.1h]
- ~~h)~~ f) inferences are made and conclusions are drawn about familiar objects and events~~.~~;
- ~~g) simple experiments are conducted to answer questions; and~~ [Moved to SOL 1.1j]
- g) a question is developed from one or more observations;
- ~~h) inferences are made and conclusions are drawn about familiar objects and events.~~ [Moved to SOL 1.1f]
- ~~f)~~ h) predictions are made based on patterns of observations ~~rather than random guesses~~;
- ~~d)~~ i) observations and data are recorded, analyzed, and communicated orally and with simple graphs, pictures, written statements, and numbers; and
- ~~g)~~ j) simple investigations and experiments are conducted to answer questions~~;~~. ~~and~~

Force, Motion, and Energy

1.2 The student will investigate and understand that moving objects exhibit different kinds of motion. Key concepts include

- a) objects may have straight, circular, and back-and-forth motions;
- b) objects may vibrate and produce sound; and
- c) pushes or pulls can change the movement of an object~~;~~. ~~and~~
- ~~d) the motion of objects may be observed in toys and in playground activities.~~ [Move to Curriculum Framework]

Matter

1.3 The student will investigate and understand how different common materials interact with water. Key concepts include

a) some liquids will separate when mixed with water, but others will not;
b) some ~~common~~ solids will dissolve in water, but others will not; and
c) some substances will dissolve more readily in hot water than in cold water.

Life Processes

1.4 The student will investigate and understand that plants have basic life needs and functional parts and can be classified according to certain characteristics. Key concepts include

a) plants need~~s (food~~ nutrients, air, water, light, and a place to grow~~)~~;
b) basic parts of many plants include ~~(~~seeds, roots, stems, leaves, ~~blossoms,~~ flowers, and fruits~~)~~; and
c) plants can be classified based on a variety of characteristics ~~(edible/nonedible, flowering/nonflowering, evergreen/deciduous)~~ [Move to Curriculum Framework].

1.5 The student will investigate and understand that animals, including ~~people~~ humans, have ~~life~~ basic needs and ~~specific physical~~ certain distinguishing characteristics. ~~and can be classified according to certain characteristics.~~ Key concepts include

a) ~~life~~ basic needs include adequate ~~(air,~~ food, water~~, and a suitable place to live)~~ shelter, and space (habitat);
b) some physical characteristics include ~~(~~body coverings, body shape, appendages, and methods of movement~~)~~; and
c) ~~other characteristics~~ animals can be classified according to a variety of characteristics ~~(wild/tame, water homes/land homes)~~ [Move to Curriculum Framework].

Interrelationships in Earth/Space Systems

1.6 The student will investigate and understand the basic relationships between the sun and ~~the~~ Earth. Key concepts include

a) the sun is the source of heat and light that warms the land, air, and water; and
~~b) night and day are caused by the rotation of the Earth.~~
b) the sun's relative position in the morning is east and in the late afternoon is west.

Earth Patterns, Cycles, and Change

1.7 The student will investigate and understand that weather changes from day to day and over the seasons, and that there is a ~~the~~ relationship ~~of~~ between daily and seasonal weather changes and ~~weather to~~ the activities and life processes of plants and animals, including humans. Key concepts include ~~how temperature, light, and precipitation bring about changes in~~

~~a) plants (growth, budding, falling leaves, and wilting);~~ [Move to Curriculum Framework]
~~b) animals (behaviors, hibernation, migration, body covering, and habitat); and~~ [Move to Curriculum Framework]
~~c) people (dress, recreation, and work).~~ [Move to Curriculum Framework]
a) simple tracking of changes in temperature, light, and precipitation over time; and
b) the effects of changes in temperature, light, and precipitation on plants, animals, and humans.

Earth Resources

1.8 The student will investigate and understand that natural resources are limited. Key concepts include

a) identification of natural resources ~~(plants and animals, water, air, land, minerals, forests, and soil)~~ [Move to Curriculum Framework];

b) factors that affect air and water quality; and

c) recycling, reusing, and reducing consumption of natural resources.

Grade Two

The second-grade standards continue to focus on using a broad range of science skills in understanding the natural world. Making detailed observations, drawing conclusions, and recognizing unusual or unexpected data are stressed as skills needed for using and validating information. Measurement in both English and metric units is stressed. The idea of living systems is introduced through habitats and the interdependence of living and nonliving things. The concept of change is explored in ~~states~~ phases of matter, life cycles, weather patterns, and seasonal effects on plants and animals.

Scientific Investigation, Reasoning, and Logic

2.1 The student will demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

- ~~a) observation is differentiated from personal interpretation, and conclusions are drawn based on observations;~~ [Moved to SOL 2.1i]
- a) observations and predictions are made and questions are formed;
- b) observations are repeated to ensure accuracy;
- c) two or more ~~attributes~~ characteristics or properties are used to classify items;
- ~~d) conditions that influence a change are defined;~~ [Moved to SOL 2.1f]
- ~~e) length, volume, mass, and temperature measurements are made in metric units (centimeters, meters, liters, degrees Celsius, grams, kilograms) and standard English units (inches, feet, yards, cups, pints, quarts, gallons, degrees Fahrenheit, ounces, pounds);~~ [Moved to SOL 2.1d]
- ~~e)~~ d) length, volume, mass, and temperature ~~measurements are made~~ are measured in metric units ~~(centimeters, meters, liters, degrees Celsius, grams, kilograms)~~ [Move to Curriculum Framework] and standard English units ~~(inches, feet, yards, cups, pints, quarts, gallons, degrees Fahrenheit, ounces, pounds)~~ [Move to Curriculum Framework] using the proper tools;
- e) time is measured using the proper tools;
- ~~f) pictures and bar graphs are constructed using numbered axes;~~ [Moved to SOL 2.1g]
- ~~d)~~ f) conditions that influence a change are ~~defined~~ identified and inferences are made;
- ~~g) unexpected or unusual quantitative data are recognized; and~~ [Moved to SOL 2.1h]
- ~~f)~~ g) data are collected and recorded, ~~pictures~~ and bar graphs are constructed using numbered axes;
- ~~h) simple physical models are constructed.~~ [Moved to SOL 2.1k]
- ~~g)~~ h) data are analyzed, and unexpected or unusual quantitative data are recognized; ~~and~~
- ~~a)~~ i) ~~observation is differentiated from personal interpretation, and~~ conclusions are drawn ~~based on observations~~;
- j) observations and data are communicated with simple bar graphs, pictures, written statements, and numbers; and
- ~~h)~~ k) simple physical models are constructed to clarify explanations and show relationships.

Force, Motion, and Energy

2.2 The student will investigate and understand that natural and artificial magnets have certain characteristics and attract specific types of metals. Key concepts include

a) magnetism, iron, magnetic/nonmagnetic, poles, attract/repel; and

b) important applications of magnetism ~~including the magnetic compass.~~[Move to Curriculum Framework]

Matter

2.3 The student will investigate and understand basic properties of solids, liquids, and gases. Key concepts include

~~a)~~ ~~mass and volume; and~~ [Moved to SOL 2.3b]

~~b)~~ ~~processes involved with changes in matter from one state to another (condensation, evaporation, melting, and freezing).~~ [Moved to SOL 2.3c]

a) identification of distinguishing characteristics of solids, liquids, and gases;

~~a)~~ b) measurement of the mass and volume of solids and liquids; and

~~b)~~ c) ~~processes involved with~~ changes in phases of matter ~~from one state to another~~ with the addition or removal of heat ~~(condensation, evaporation, melting, and freezing)~~ [Move to Curriculum Framework].

Life Processes

2.4 The student will investigate and understand that plants and animals undergo a series of orderly changes ~~in their life cycles~~ as they mature and grow. Key concepts include

a) ~~some animals (frogs and butterflies) undergo distinct stages during their lives, while others generally resemble their parents~~ [Move to Curriculum Framework] animal life cycles; and

b) ~~flowering plants undergo many changes, from the formation of the flower to the development of the fruit~~ [Move to Curriculum Framework] plant life cycles.

Living Systems

2.5 The student will investigate and understand that living things are part of a system. Key concepts include

a) living organisms are interdependent with their living and nonliving surroundings; ~~and~~

b) an animal's home is its habitat and a habitat includes adequate food, water, shelter or cover, and space;

~~b)~~ c) habitats change over time due to many influences~~.~~; and

d) fossils provide information about living systems that were on Earth years ago.

Interrelationships in Earth/Space Systems

2.6 The student will investigate and understand basic types, changes, and patterns of weather. Key concepts include

a) ~~temperature, wind, precipitation, drought, flood, and storms~~ [Move to Curriculum Framework] identification of common storms and weather phenomena; ~~and~~

b) the uses and importance of measuring, ~~and~~ recording, and interpreting weather data~~.~~; and

c) the importance and uses of measuring and tracking weather data over time.

Earth Patterns, Cycles, and Change

2.7 The student will investigate and understand that weather and seasonal changes affect plants, animals, and their surroundings. Key concepts include

a) effects of weather and seasonal changes on the growth and behavior of living things ~~(migration, hibernation, camouflage, adaptation, dormancy)~~ [Move to Curriculum Framework]; and

b) weathering, ~~and~~ erosion, and deposition of ~~the~~ land surfaces.

Earth Resources

2.8 The student will investigate and understand that plants produce oxygen and food, are a source of useful products, and provide benefits in nature. Key concepts include

a) important plant products are identified and classified ~~(fiber, cotton, oil, spices, lumber, rubber, medicines, and paper)~~ [Move to Curriculum Framework];

b) the availability of plant products affects the development of a geographic area; ~~and~~

c) plants provide oxygen, homes and food for many animals ~~and prevent soil from washing away.~~; and

d) plants can prevent soil from washing away.

Grade Three

The third-grade standards place increasing emphasis on conducting investigations. Students are expected to be able to develop questions, formulate simple hypotheses, make predictions, gather data, and use the metric system with greater precision. Using information to make inferences and draw conclusions becomes more important. In the area of physical science, the standards focus on simple and compound machines, energy, and a basic understanding of matter. Behavioral, ~~and~~ physical, and chemical adaptations are examined in relation to the life needs of animals. The notion of living systems is further explored in aquatic and terrestrial food chains and diversity in ~~environments~~ ecosystems. Patterns in the natural world are demonstrated in terms of the phases of the moon, tides, seasonal changes, the water cycle, and animal and plant life cycles. Geological concepts are introduced through the investigation of the components of soil.

Scientific Investigation, Reasoning, and Logic

3.1 The student will demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

- a) ~~predictions and~~ observations are made and are repeated to ensure accuracy;
- b) predictions are formulated using a variety of sources of information;
- ~~c)~~ ~~questions are developed to formulate hypotheses;~~ [Moved to SOL 3.1g]
- ~~b)~~ c) objects with similar characteristics or properties are classified into at least two sets and two subsets;
- ~~d)~~ ~~volume is measured to the nearest milliliter and liter;~~ [Move to SOL 3.1e]
- ~~k)~~ d) natural events are sequenced chronologically~~.~~;
- ~~e)~~ ~~length is measured to the nearest centimeter;~~ [Move to SOL 3.1e]
- ~~f)~~ ~~mass is measured to the nearest gram;~~ [Move to SOL 3.1e]
- ~~g)~~ ~~data are gathered, charted, and graphed (line plot, picture graph, and bar graph);~~ [Moved to SOL 3.1h]
- ~~h)~~ ~~temperature is measured to the nearest degree Celsius;~~ [Move to SOL 3.1e]
- e) length, volume, mass and temperature are measured in metric and standard English units using proper tools and techniques;
- ~~i)~~ ~~time is measured to the nearest minute;~~ [Move to SOL 3.1f]
- ~~i)~~ f) time is measured to the nearest minute using proper tools and techniques;
- ~~e)~~ g) questions are developed to formulate hypotheses;
- ~~g)~~ h) data are gathered, charted, ~~and~~ graphed, and analyzed; ~~(line plot, picture graph, and bar graph)~~ [Move to Curriculum Framework]
- i) unexpected or unusual quantitative data are recognized;
- j) inferences are made and conclusions are drawn; and
- ~~k)~~ ~~natural events are sequenced chronologically.~~ [Move to SOL 3.1d]
- k) data are communicated with simple graphs, pictures, and written statements.

Force, Motion, and Energy

3.2 The student will investigate and understand simple machines and their uses. Key concepts include

~~b)~~ a) ~~how simple machines~~ purpose and function of simple machines;

~~a)~~ b) types of simple machines ~~(lever, screw, pulley, wheel and axle, inclined plane, and wedge)~~; [Move to Curriculum Framework]

~~b) how simple machines function;~~ [Moved to SOL 3.2a]

c) compound machines ~~(scissors, wheelbarrow, and bicycle)~~; [Move to Curriculum Framework] and

d) examples of simple and compound machines found in the school, home, and work environments.

Matter

3.3 The student will investigate and understand that objects are made of materials that can be described by their physical properties. Key concepts include

a) objects are made of one or more materials;

~~b) materials are composed of parts that are too small to be seen without magnification; and~~ [Move to Grade 5 Curriculum Framework]

~~c) physical properties remain the same as the material is reduced in size.~~ [Moved to SOL 3.3b]

~~c)~~ b) physical properties remain the same as the material is ~~reduced~~ changed in visible size~~.~~; and

c) visible physical changes are identified.

Life Processes

3.4 The student will investigate and understand that ~~behavioral, and physical~~ adaptations allow animals to ~~respond to~~ satisfy life needs and respond to the environment. Key concepts include

a) ~~methods of gathering and storing food, finding shelter, defending themselves, and rearing young~~ [Move to Curriculum Framework] behavioral adaptations; ~~and~~

b) ~~hibernation, migration, camouflage, mimicry, instinct, and learned behavior~~ [Move to Curriculum Framework] physical adaptations;~~.~~ and

c) chemical adaptations.

Living Systems

3.5 The student will investigate and understand relationships among organisms in aquatic and terrestrial food chains. Key concepts include

a) producer, consumer, decomposer;

b) herbivore, carnivore, omnivore; and

c) predator and prey.

3.6 The student will investigate and understand that ~~environments~~ ecosystems support a diversity of plants and animals that share limited resources. Key concepts include

a) ~~water-related~~ aquatic ~~environments~~ ecosystems; ~~(pond, marshland, swamp, stream, river, and ocean environments)~~ [Move to Curriculum Framework];

b) ~~dry-land~~ terrestrial ~~environments~~ ecosystems ~~(desert, grassland, rain forest, and forest environments)~~ [Move to Curriculum Framework]; ~~and~~

c) ~~population~~ populations and ~~community~~ communities~~.~~; and

d) the human role in conserving limited resources.

Interrelationships in Earth/Space Systems

3.7 The student will investigate and understand the major components of soil, its origin, and importance to plants and animals including humans. Key concepts include

a) soil provides the support and nutrients necessary for plant growth;

b) topsoil is a natural product of subsoil and bedrock;

c) rock, clay, silt, sand, and humus are components of soils; and

d) soil is a natural resource and should be conserved.

Earth Patterns, Cycles, and Change

3.8 The student will investigate and understand basic patterns and cycles occurring in nature. Key concepts include

a) patterns of natural events ~~(~~ such as day and night, seasonal changes, simple phases of the moon, and tides~~)~~; ~~and~~

b) animal ~~and plant~~ life cycles~~.~~; and

c) plant life cycles.

3.9 The student will investigate and understand the water cycle and its relationship to life on Earth. Key concepts include

a) there are many sources of water on Earth;

~~a)~~ b) the energy from the sun drives the water cycle;

~~b)~~ c) ~~processes involved in~~ the water cycle involves several processes ~~(evaporation, condensation, precipitation)~~; [Move to Curriculum Framework]

~~c)~~ d) water is essential for living things; and

~~d)~~ e) ~~water supply and~~ water ~~conservation~~ on Earth is limited and needs to be conserved.

Earth Resources

3.10 The student will investigate and understand that natural events and human influences can affect the survival of species. Key concepts include

a) the interdependency of plants and animals;

b) the effects of human activity on the quality of air, water, and habitat;

c) the effects of fire, flood, disease, and erosion on organisms; and

d) conservation and resource renewal.

3.11 The student will investigate and understand different sources of energy. Key concepts include

a) the sun's ability to produce light and heat energy;

b) sources of energy ~~(sunlight, water, wind)~~ [Move to Curriculum Framework];

c) fossil fuels ~~(coal, oil, natural gas)~~ ~~and wood~~ [Move to Curriculum Framework]; and

d) renewable and nonrenewable energy resources.

Grade Four

The fourth-grade standards stress the importance of using information, analyzing data, and validating experimental results. Defining variables in experimentation is emphasized, and making simple predictions from picture, bar, and basic line graphs is underscored. Questioning and hypothesizing become more detailed at this level. Students are introduced to basic principles of electricity and to the concept of motion. Students explore basic information about our solar system and ~~Relationships are investigated~~ ~~in~~ investigate the interactions among the Earth, moon, and sun. ~~and~~ Students explore basic plant anatomy, plant adaptations, and investigate relationships among plants and animals and their environments. In examining weather phenomena and conditions, students identify various factors, make predictions based on data, and evaluate the results. The importance of natural resources in Virginia is emphasized.

Scientific Investigation, Reasoning, and Logic

4.1 The student will demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

- a) distinctions are made among observations, conclusions, inferences, and predictions;
- b) objects or events are classified and arranged according to characteristics or properties;
- ~~d)~~ c) appropriate instruments are selected and used to measure ~~linear distance,~~ length, mass, volume, ~~mass,~~ and temperature in metric units;
- d) appropriate instruments are selected and used to measure elapsed time;
- ~~e)~~ ~~appropriate metric measures are used to collect, record, and report data;~~
- ~~h)~~ e) predictions and inferences are made, and conclusions are drawn ~~based on data from picture graphs, bar graphs, and basic line graphs~~ from a variety of sources~~.~~;
- f) independent and dependent variables are identified;
- ~~c)~~ g) ~~variables that must be held~~ constants in an experimental situation are ~~defined~~ identified;
- ~~b)~~ h) hypotheses are ~~formulated based on~~ developed as cause-and-effect relationships;
- ~~f)~~ i) data are collected, recorded, analyzed and displayed using bar and basic line graphs~~;~~, and using metric measurements;
- ~~g)~~ j) numerical data that are contradictory or unusual in experimental results are recognized; ~~and~~
- k) data are communicated with simple graphs, pictures, written statements, and numbers; and
- l) models are constructed to clarify explanations or demonstrate relationships.

Force, Motion, and Energy

4.2 The student will investigate and understand characteristics and interaction of moving objects. Key concepts include

- a) motion is described by an object's direction and speed;
- b) ~~forces cause~~ changes in motion~~;~~ are related to force and mass;
- c) friction is a force that opposes motion; and
- d) moving objects have kinetic energy.

4.3 The student will investigate and understand the characteristics of electricity. Key concepts include

a) conductors and insulators;
b) basic circuits ~~(open/closed, parallel/series)~~ [Move to Curriculum Framework];
c) static electricity;
d) the ability of electrical energy to be transformed into heat, light, and ~~mechanical energy~~ motion;
e) simple electromagnets and magnetism; and
f) historical contributions in understanding electricity.

Life Processes

4.4 The student will investigate and understand basic plant anatomy and life processes. Key concepts include

a) the structures of typical plants ~~(leaves, stems, roots, and flowers)~~ [Move to Curriculum Framework] and the function of each structure;
b) processes and structures involved with plant reproduction ~~(pollination, stamen, pistil, sepal, embryo, spore, and seed)~~ [Move to Curriculum Framework]; and
c) photosynthesis ~~(sunlight, chlorophyll, water, carbon dioxide, oxygen, and sugar)~~ [Move to Curriculum Framework]~~; and~~.
~~d)~~ ~~dormancy.~~

4.5 The student will investigate and understand that adaptations allow plants to satisfy life needs and respond to the environment. Key concepts include

a) behavioral adaptations;
b) physical adaptations; and
c) chemical adaptations.

Living Systems

~~4.5~~ 4.6 The student will investigate and understand how plants, ~~and~~ animals, and humans in an ecosystem interact with one another and with the nonliving ~~environment~~ components in the ecosystem. Key concepts include

~~a)~~ ~~behavioral and structural adaptations;~~ [Moved to new SOL 4.5]
~~b)~~ a) organization of populations, communities, and ecosystems and how they interrelate;
~~c)~~ b) flow of energy through food webs;
~~d)~~ c) habitats and niches;
~~e)~~ d) changes in an organism's niche at various stages in its life cycle~~s~~; and
~~f)~~ e) influence of human activity on ecosystems.

Interrelationships in Earth/Space Systems

~~4.6~~ 4.7 The student will investigate and understand how weather conditions and phenomena occur and can be predicted. Key concepts include

~~b)~~ a) weather phenomena ~~(fronts, clouds, and storms)~~ [Move to Curriculum Framework]~~.~~;
~~a)~~ b) weather measurements and meteorological tools ~~(air pressure – barometer, wind speed – anemometer, rainfall – rain gauge, and temperature – thermometer)~~ [Move to Curriculum Framework]; and
c) use of weather measurements and weather phenomena to make weather predictions.

Earth Patterns, Cycles, and Change

4.8 The student will investigate and understand the organization of the solar system. Key concepts include

a) the planets in the solar system;
b) the order of the planets in the solar system; and
c) the relative sizes of the planets.

~~4.7~~ 4.9 The student will investigate and understand the relationships among the Earth, moon, and sun. Key concepts include

a) the motions of the Earth, moon, and sun ~~(revolution and rotation)~~ [Move to Curriculum Framework];
b) the causes for the Earth's seasons ~~and phases of the moon~~;
c) the causes for the phases of the moon;
~~e)~~ d) the relative size, position, age, and makeup of the Earth, moon, and sun; and
~~d)~~ e) historical contributions in understanding the Earth-moon-sun system.

Earth Resources

~~4.8~~ 4.10 The student will investigate and understand important Virginia natural resources. Key concepts include

a) watersheds and water resources;
b) animals and plants;
c) minerals, rocks, ores, and energy sources; and
d) forests, soil, and land.

Grade Five

The fifth-grade standards emphasize the importance of selecting appropriate instruments for measuring and recording observations. The organization, analysis, and application of data continue to be an important focus of classroom inquiry. Science skills from preceding grades, including questioning, using and validating evidence, and systematic experimentation, are reinforced at this level. Students are introduced to more detailed concepts of sound and light and the tools used for studying them. Key concepts of matter, including those about atoms, molecules, elements, and compounds, are studied, and the properties of matter are defined in greater detail. The cellular makeup of organisms and the distinguishing characteristics of groups of organisms are stressed. Students learn about the characteristics of the oceans and Earth's changing surface.

The fifth-grade standards focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

Scientific Investigation, Reasoning, and Logic

5.1 The student will demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

a) items such as rocks, minerals, and organisms are identified using ~~a~~ various classification keys;

b) ~~estimations~~ estimates and accurate measurements of length, mass, and volume are made in metric units using proper tools;

~~c) appropriate instruments are selected and used for making quantitative observations of length, mass, volume, and elapsed time;~~

c) estimates of accurate measurements of elapsed time are made using proper tools;

~~d) accurate measurements are made using basic tools (thermometer, meter stick, balance, graduated cylinder)~~ [Move list to Curriculum Framework]

d) hypotheses are formed from testable questions;

~~g)~~ e) ~~manipulated and responding~~ independent and dependent variables are identified; ~~and~~

f) constants in an experimental situation are identified;

~~e)~~ g) data are collected, recorded, analyzed and reported using ~~the appropriate~~ proper graphical representations ~~(graphs, charts, diagrams)~~ [Move to Curriculum Framework] and using metric measurements;

~~h) an understanding of the nature of science is developed and reinforced.~~

~~f)~~ h) predictions are made using patterns from data collected, and simple graphical data are ~~extrapolated~~ generated; and

i) inferences are made and conclusions are drawn.

Force, Motion, and Energy

5.2 The student will investigate and understand how sound is transmitted and how it is used~~ as a means of communication~~. Key concepts include

a) compression waves;

~~a)~~ b) vibration, compression, wavelength, ~~vibration~~, frequency, amplitude;

~~b)~~ c) the ability of different media (solids, liquids, and gases) to transmit sound; and

~~c)~~ d) uses and applications of sound waves ~~(voice, sonar, animal sounds, and musical instruments)~~ [Move to Curriculum Framework].

5.3 The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include

a) ~~the visible spectrum and light waves~~ transverse waves;

b) the visible spectrum;

~~d)~~ c) opaque, transparent, and translucent; ~~and~~

~~e)~~ d) reflection of light from reflective surfaces ~~(mirrors)~~ [Move to Curriculum Framework]; and

~~e)~~ ~~historical contributions in understanding light.~~

~~b)~~ e) refraction of light through water and prisms~~;~~.

Matter

5.4 The student will investigate and understand that matter is anything that has mass, takes up space, and occurs as a solid, liquid, or gas. Key concepts include

a) distinguishing properties of each phase of matter;

~~a)~~ b) atoms~~,~~ and elements~~, molecules, and compounds~~;

~~c)~~ ~~the effect of heat on the states of matter.~~

c) molecules and compounds; and

~~b)~~ d) mixtures including solutions~~; and~~.

Living Systems

5.5 The student will investigate and understand that organisms are made of one or more cells and have distinguishing characteristics~~.~~ that play a vital role in the organism's ability to survive and thrive in its environment. Key concepts include

a) basic cell structures and functions;

~~b)~~ ~~kingdoms of living things;~~ [Move to Curriculum Framework]

b) classification of organisms using physical characteristics, body structures, and behavior of the organism; and

~~c)~~ ~~vascular and nonvascular plants; and~~ [Move to Curriculum Framework]

c) traits of organisms that allow them to survive in their environment.

~~d)~~ ~~vertebrates and invertebrates.~~ [Move to Curriculum Framework]

Interrelationships in Earth/Space Systems

5.6 The student will investigate and understand characteristics of the ocean environment. Key concepts include

a) geological characteristics ~~(continental shelf, slope, rise)~~ [Move to Curriculum Framework];

b) physical characteristics ~~(depth, salinity, major currents)~~ [Move to Curriculum Framework]; and

c) ~~biological~~ ecological characteristics ~~(ecosystems)~~ [Move to Curriculum Framework].

Earth Patterns, Cycles, and Change

5.7 The student will investigate and understand how the Earth's surface is constantly changing. Key concepts include

a) the rock cycle including identification of and transformations between rock types;

b) Earth history and fossil evidence;

c) the basic structure of the Earth's interior;

d) changes in the Earth's crust due to plate tectonics ~~(earthquakes and volcanoes)~~ [Move to Curriculum Framework];

e) weathering, ~~and~~ erosion, and deposition; and

f) human impact.

Grade Six

The sixth-grade standards continue to emphasize data analysis and experimentation. Methods are studied for testing the validity of predictions and conclusions. Scientific methodology, focusing on precision in stating hypotheses and defining dependent and independent variables, is strongly reinforced. The concept of change is explored through the study of transformations of energy and matter. The standards present an integrated focus on the role of the sun's energy in the Earth's systems, on water in the environment, on air and atmosphere, and on basic chemistry concepts. A more detailed understanding of the solar system and space exploration becomes a focus of instruction. Natural resource management, its relation to public policy, and cost/benefit tradeoffs in conservation policies are introduced.

The sixth-grade standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

Scientific Investigation, Reasoning, and Logic

6.1 The student will ~~plan and conduct~~ demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

a) observations are made involving fine discrimination between similar objects and organisms;

~~b)~~ ~~a classification system is developed based on multiple attributes~~; [Moved to SOL LS.1b]

~~c)~~ b) precise and approximate measurements are recorded;

~~d)~~ c) scale models are used to estimate distance, volume, and quantity;

~~e)~~ d) hypotheses are stated in ways that identify the independent ~~(manipulated)~~ and dependent ~~(responding)~~ variables;

~~f)~~ e) a method is devised to test the validity of predictions and inferences;

~~g)~~ f) one variable is manipulated over time, using many repeated trials;

~~h)~~ g) data are collected, recorded, analyzed, and reported using ~~appropriate~~ metric measurements and tools;

~~i)~~ h) data are ~~organized~~ analyzed and communicated through graphical representation ~~(graphs, charts, and diagrams)~~; [Move to Curriculum Framework]

~~j)~~ i) models and simulations are ~~designed to explain a sequence~~used to illustrate and explain phenomena and systems; and
~~an understanding of the nature of science is developed and reinforced~~. [Moved to SOL 6.1]

j) current applications are used to reinforce science concepts.

Force, Motion, and Energy

6.2 The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts include

a) potential and kinetic energy;
b) the role of the sun in the formation of most energy sources on Earth;
c) nonrenewable energy sources ~~(fossil fuels including petroleum, natural gas, and coal)~~; [Move to Curriculum Framework]
d) renewable energy sources ~~(wood, wind, hydro, geothermal, tidal, and solar)~~; and [Move to Curriculum Framework]
e) energy transformations (~~heat/light to mechanical, chemical, and electrical energy)~~. [Move to Curriculum Framework]

6.3 The student will investigate and understand the role of solar energy in driving most natural processes within the atmosphere, the hydrosphere, and on the Earth's surface. Key concepts include

a) the Earth's energy budget;
b) the role of radiation and convection in the distribution of energy;
c) the motion of the atmosphere and the oceans;
d) cloud formation; and
e) the role of ~~heat~~ thermal energy in weather-related phenomena including thunderstorms and hurricanes.

Matter

6.4 The student will investigate and understand that all matter is made up of atoms. Key concepts include

a) atoms ~~are made up of~~ consist of fundamental particles, including electrons, protons, and neutrons;
b) atoms of any element are alike but are different from atoms of other elements;
c) elements may be represented by chemical symbols;
d) two or more atoms ~~may be chemically combined~~ interact to form new substances, which are held together by electrical forces (bonds);
e) compounds may be represented by chemical formulas;
f) chemical equations can be used to model chemical changes; and
g) a limited number of elements comprise the largest portion of the solid Earth, living matter, the oceans, and the atmosphere.

6.5 The student will investigate and understand the unique properties and characteristics of water and its roles in the natural and human-made environment. Key concepts include

a) water as the universal solvent;
b) the properties of water in all three ~~states~~ phases;
c) the action of water in physical and chemical weathering;
d) the ability of large bodies of water to store heat and moderate climate;
e) the origin and occurrence of water on Earth;
f) the importance of water for agriculture, power generation, and public health; and
g) the importance of protecting and maintaining water resources.

6.6 The student will investigate and understand the properties of air and the structure and dynamics of the Earth's atmosphere. Key concepts include

a) air as a mixture of gaseous elements and compounds;
b) ~~air~~ pressure, temperature, and humidity;
c) ~~how the atmosphere~~ atmospheric changes with altitude;
d) natural and human-caused changes to the atmosphere and the importance of protecting and maintaining air quality;
e) the relationship of atmospheric measures and weather conditions; and
f) basic information from weather maps, including fronts, systems, and basic measurements~~; and~~.
g) ~~the importance of protecting and maintaining air quality~~. [Moved to SOL 6.6d]

Living Systems

6.7 The student will investigate and understand the natural processes and human interactions that affect watershed systems. Key concepts include

a) the health of ecosystems and the abiotic factors of a watershed;
b) the location and structure of Virginia's regional watershed systems;
c) divides, tributaries, river systems, and river and stream processes;
d) wetlands;
e) estuaries;
f) major conservation, health, and safety issues associated with watersheds; and
g) water monitoring and analysis using field equipment including hand-held technology.

Interrelationships in Earth/Space Systems

6.8 The student will investigate and understand the organization of the solar system and the ~~relationships~~ interactions among the various bodies that comprise it. Key concepts include

a) the sun, moon, Earth, other planets and their moons, meteors, asteroids, and comets;
b) relative size of and distance between planets;
c) the role of gravity;
d) revolution and rotation;
e) the mechanics of day and night and the phases of the moon;
f) the unique properties of Earth as a planet;
g) the relationship of the Earth's tilt and the seasons;
h) the cause of tides; and
i) the history and technology of space exploration.

Earth Resources

6.9 The student will investigate and understand public policy decisions relating to the environment. Key concepts include

a) management of renewable resources ~~(water, air, soil, plant life, animal life)~~; [Move to Curriculum Framework]
b) management of nonrenewable resources ~~(coal, oil, natural gas, nuclear power, mineral resources)~~; [Move to Curriculum Framework]
c) the mitigation of land-use and environmental hazards through preventive measures; and
d) cost/benefit tradeoffs in conservation policies.

Life Science

The Life Science standards emphasize a more complex understanding of change, cycles, patterns, and relationships in the living world. Students build on basic principles related to these concepts by exploring the cellular organization and the classification of organisms; the dynamic relationships among organisms, populations, communities, and ecosystems; and change as a result of the transmission of genetic information from generation to generation. Inquiry skills at this level include organization and mathematical analysis of data, manipulation of variables in experiments, and identification of sources of experimental error.

The Life Science standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

LS.1 The student will ~~plan and conduct~~ demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

a) data are organized into tables showing repeated trials and means;
~~b)~~ ~~variables are defined~~;
b) a classification system is developed based on multiple attributes;
c) ~~metric units (SI – International System of Units) are used~~ triple beam and electronic balances, thermometers, metric rulers, graduated cylinders and probeware are used to gather data;
d) models and simulations are constructed and used to illustrate and explain phenomena;
e) sources of experimental error are identified;
f) dependent variables, independent variables, and constants are identified;
g) variables are controlled to test hypotheses, and trials are repeated;
h) ~~continuous line graphs are constructed, interpreted, and used to make predictions~~ data are organized, communicated through graphical representation, interpreted, and used to make predictions;
i) ~~interpretations from a set of data are evaluated and defended~~ patterns are identified in data and are interpreted and evaluated; and
~~j)~~ ~~an understanding of the nature of science is developed and reinforced.~~ [Moved to SOL LS.1]
j) current applications are used to reinforce life science concepts.

LS.2 The student will investigate and understand that all living things are composed of cells. Key concepts include

a) cell structure and organelles ~~(cell membrane, cell wall, cytoplasm, vacuole, mitochondrion, endoplasmic reticulum, nucleus, and chloroplast)~~; [Move to Curriculum Framework]
b) similarities and differences between plant and animal cells;
c) development of cell theory; and
d) cell division ~~(mitosis and meiosis)~~. [Move to Curriculum Framework]

LS.3 The student will investigate and understand that living things show patterns of cellular organization. Key concepts include

a) cells, tissues, organs, and systems; and

b) ~~life functions and processes of cells, tissues, organs, and systems (respiration, removal of wastes, growth, reproduction, digestion, and cellular transport)~~ patterns of cellular organization and their relationship to life processes in living things.

~~LS.4 The student will investigate and understand that the basic needs of organisms must be met in order to carry out life processes. Key concepts include~~

~~a) plant needs;~~

~~b) animal needs; and~~

~~c) factors that influence life processes.~~ [LS.4 is included in LS.3 and LS.5]

LS.~~5~~ 4 The student will investigate and understand how organisms can be classified. Key concepts include

a) the distinguishing characteristics of domains of organisms;

~~a)~~ b) the distinguishing characteristics of kingdoms of organisms;

~~b)~~ c) the distinguishing characteristics of major animal and plant phyla; and

~~c)~~ d) the characteristics ~~of the~~ that define a species.

LS.~~6~~ 5 The student will investigate and understand the basic physical and chemical processes of photosynthesis and its importance to plant and animal life. Key concepts include

a) energy transfer between sunlight and chlorophyll;

b) transformation of water and carbon dioxide into sugar and oxygen; and

c) photosynthesis as the foundation of virtually all food webs.

LS.~~7~~ 6 The student will investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment. Key concepts include

a) the carbon, water, and nitrogen cycles;

b) interactions resulting in a flow of energy and matter throughout the system;

c) complex relationships within terrestrial, freshwater, and marine ecosystems; and

d) energy flow in food webs and energy pyramids.

LS.~~8~~ 7 The student will investigate and understand that interactions exist among members of a population. Key concepts include

a) competition, cooperation, social hierarchy, territorial imperative; and

b) influence of behavior on a population.

LS.~~9~~ 8 The student will investigate and understand interactions among populations in a biological community. Key concepts include

a) the relationships among producers, consumers, and decomposers in food webs;

b) the relationship between predators and prey;

c) competition and cooperation;

d) symbiotic relationships; and

e) niches.

LS.~~10~~ 9 The student will investigate and understand how organisms adapt to biotic and abiotic factors in an ecosystem. Key concepts include

a) differences between ecosystems and biomes;
b) characteristics of land, marine, and freshwater ecosystems; and
c) adaptations that enable organisms to survive within a specific ecosystem.

LS.~~11~~ 10 The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic and ~~change over time (daily, seasonal, and long term)~~ respond to daily, seasonal, and long-term changes in their environment. Key concepts include

a) phototropism, hibernation, and dormancy;
b) factors that increase or decrease population size; and
c) eutrophication, climate changes, and catastrophic disturbances.

LS.~~12~~ 11 The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include

a) food production and harvest;
b) change in habitat size, quality, or structure;
c) change in species competition;
d) population disturbances and factors that threaten or enhance species survival; and
e) environmental issues ~~(water supply, air quality, energy production, and waste management)~~. [Move to Curriculum Framework]

LS.~~13~~ 12 The student will investigate and understand that organisms reproduce and transmit genetic information to new generations. Key concepts include

a) the structure and role of DNA;
b) the function of genes and chromosomes;
c) genotypes and phenotypes;
~~d)~~ ~~factors affecting the expression of traits~~;
~~e)~~ d) characteristics that can and cannot be inherited;
~~f)~~ e) genetic engineering and its applications; and
~~g)~~ f) historical contributions and significance of discoveries related to genetics.

LS.~~14~~ 13 The student will investigate and understand that ~~organisms~~ populations of organisms change over time. Key concepts include

a) the relationships of mutation, adaptation, natural selection, and extinction;
b) evidence of evolution of different species in the fossil record; and
c) how environmental influences, as well as genetic variation, can lead to diversity of organisms.

Physical Science

The Physical Science standards continue to build on skills of systematic investigation with a clear focus on variables and repeated trials. Validating conclusions using evidence and data becomes increasingly important at this level. Students will plan and conduct research involving both classroom experimentation and literature reviews from written and electronic resources. Research methods and skills highlight practical problems and questions. Students will share their work, using written reports and other presentations.

The Physical Science standards stress an in-depth understanding of the nature and structure of matter and the characteristics of energy. The standards place considerable emphasis on the technological application of physical science principles. Major areas covered by the standards include the organization and use of the periodic table; physical and chemical changes; nuclear reactions; temperature and heat; sound; light; electricity and magnetism; and work, force, and motion.

The Physical Science standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

PS.1 The student will ~~plan and conduct~~ demonstrate an understanding of scientific reasoning, logic and the nature of science by planning and conducting investigations in which

a) chemicals and equipment are used safely;
b) length, mass, volume, density, temperature, weight, and force are accurately measured ~~and reported using metric units (SI – International System of Units)~~;
c) conversions are made among metric units, applying appropriate prefixes;
d) triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, probeware, and spring scales are used to gather data;
e) numbers are expressed in scientific notation where appropriate;
~~f)~~ ~~research skills are utilized using a variety of resources;~~
~~g)~~ f) independent and dependent variables, constants, controls, and repeated trials are identified;
~~h)~~ g) data tables showing the independent and dependent variables, derived quantities, and the number of trials are constructed and interpreted;
~~i)~~ h) data tables for descriptive statistics showing specific measures of central tendency, the range of the data set, and the number of repeated trials are constructed and interpreted;
~~j)~~ i) frequency distributions, scattergrams, line plots, and histograms are constructed and interpreted;
~~k)~~ j) valid conclusions are made after analyzing data;
~~l)~~ k) research methods are used to investigate practical problems and questions;
~~m)~~ l) experimental results are presented in appropriate written form; and
~~n)~~ ~~an understanding of the nature of science is developed and reinforced.~~ [Moved to SOL PS.1]
m) current applications of physical science concepts are used.

PS.2 The student will investigate and understand the ~~basic~~ nature of matter. Key concepts include

a) the particle theory of matter;
b) elements, compounds, mixtures, acids, bases, and salts;
c) solids, liquids, and gases;
~~d)~~ ~~characteristics of types of matter based on physical and chemical properties;~~ [Moved to SOL PS.2f]
~~e)~~ d) physical properties ~~(shape, density, solubility, odor, melting point, boiling point, color)~~; ~~and~~ [Move to Curriculum Framework]
~~f)~~ e) chemical properties ~~(acidity, basicity, combustibility, reactivity).~~; and [Move to Curriculum Framework]
f) characteristics of types of matter based on physical and chemical properties.

PS.3 The student will investigate and understand the modern and historical models of atomic structure. Key concepts include

a) the contributions of Dalton, Thomson, Rutherford, and Bohr in understanding the atom; and
b) the modern model of atomic structure.

PS.4 The student will investigate and understand the organization and use of the periodic table of elements to obtain information. Key concepts include

a) symbols, atomic number, ~~atomic mass~~ mass number, chemical families (groups), and periods;
b) classification of elements as metals, metalloids, and nonmetals; and
c) ~~simple compounds (formulas and the nature of bonding)~~formation of compounds through ionic and covalent bonding.

PS.5 The student will investigate and understand changes in matter and the relationship of these changes to the Law of Conservation of Matter and Energy. Key concepts include

a) physical changes;
~~b)~~ ~~nuclear reactions (products of fusion and fission and the effect of these products on humans and the environment); and~~ [Moved to SOL PS.5c]
~~c)~~ b) chemical changes ~~(types of reactions, reactants, and products; and balanced equations).~~; and [Move to Curriculum Framework]
c) nuclear reactions. ~~(products of fusion and fission and the effect of these products on humans and the environment); and~~ [Move to Curriculum Framework]

PS.6 The student will investigate and understand states and forms of energy and how energy is transferred and transformed. Key concepts include

a) potential and kinetic energy;
b) mechanical, chemical, and electrical energy; and
c) ~~heat, light, and~~ sound, thermal, radiant and nuclear energy.

PS.7 The student will investigate and understand temperature scales, heat, and ~~heat~~ thermal energy ~~transfer~~. Key concepts include

a) Celsius and Kelvin temperature scales and absolute zero;
b) phase change, freezing point, melting point, boiling point, vaporization, and condensation;
c) conduction, convection, and radiation; and
d) applications of heat transfer ~~(heat engines, thermostats, refrigeration, and heat pumps)~~. [Move to Curriculum Framework]

PS.8 The student will investigate and understand the characteristics of sound waves and ~~technological applications of~~ sound ~~waves~~. Key concepts include

a) wavelength, frequency, speed, ~~and~~ amplitude, rarefaction, and compression;
b) resonance;
c) the nature of ~~mechanical~~ compression waves; and
d) technological applications of sound.

PS.9 The student will investigate and understand the ~~nature~~ characteristics of transverse waves and ~~technological applications of~~ light. Key concepts include

a) wavelength, frequency, speed, amplitude, crest, and trough;
~~a)~~ b) the wave behavior of light ~~(reflection, refraction, diffraction, and interference)~~; [Move to Curriculum Framework]
~~b)~~ c) images formed by lenses and mirrors; ~~and~~
~~c)~~ d) the electromagnetic spectrum; and
e) technological applications of light.

PS.10 The student will investigate and understand the scientific principles ~~and technological applications~~ of work, force, and motion. Key concepts include

a) speed, velocity, and acceleration;
b) Newton's laws of motion;
c) work, force, mechanical advantage, efficiency, and power; and
d) technological applications of work, force, and motion ~~(simple machines, compound machines, powered vehicles, rockets, and restraining devices)~~. [Move to Curriculum Framework]

PS.11 The student will investigate and understand basic principles of electricity and magnetism. Key concepts include

a) static electricity, current electricity, and circuits;
b) relationship between a magnetic field~~s~~ and ~~electromagnets~~ an electric current;
c) electromagnets, motors, and generators and their uses~~.~~; and
d) conductors, semiconductors, and insulators.

Earth Science

The Earth Science standards connect the study of ~~the~~ Earth's composition, structure, processes, and history; its atmosphere, fresh water, and oceans; and its environment in space. The standards emphasize historical contributions in the development of scientific thought about ~~the~~ Earth and space. The standards stress the interpretation of maps, charts, tables, and profiles; the use of technology to collect, analyze, and report data; and the utilization of science skills in systematic investigation. Problem solving and decision making are an integral part of the standards, especially as they relate to the costs and benefits of utilizing ~~the~~ Earth's resources. Major topics of study include plate tectonics, the rock cycle, Earth history, the oceans, the atmosphere, ~~weather and~~ climate, and the solar system and universe.

The Earth Science standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

ES.1 The student will plan and conduct investigations in which

a) volume, area, mass, elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools;

b) technologies, including computers, probeware, and ~~global positioning systems (GPS)~~ geospatial technologies, are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions;

c) scales, diagrams, ~~maps~~, charts, graphs, tables, imagery, models and profiles are constructed and interpreted;

d) maps and globes are read and interpreted, including location by latitude and longitude;

~~d)~~ e) variables are manipulated with repeated trials; and

~~e) a scientific viewpoint is constructed and defended (the nature of science).~~

f) current applications are used to reinforce Earth science concepts.

ES.2 The student will demonstrate the nature of science and scientific reasoning and logic ~~by~~. Key concepts include

a) ~~analyzing how~~ science explains and predicts the interactions and dynamics of complex Earth systems;

b) ~~recognizing that~~ evidence is required to evaluate hypotheses and explanations;

~~c) comparing different scientific explanations for a set of observations about the Earth~~;

~~d)~~ c) ~~explaining that~~ observation and logic are essential for reaching a conclusion; and

~~e)~~ d) ~~evaluating~~ evidence is evaluated for scientific theories.

~~ES.3~~ ~~The student will investigate and understand how to read and interpret maps, globes, models, charts, and imagery. Key concepts include~~

~~a)~~ ~~maps (bathymetric, geologic, topographic, and weather) and star charts;~~ [Moved to SOL ES.1d and Curriculum Framework]

~~b)~~ ~~imagery (aerial photography and satellite images);~~ [Moved to SOL ES.1c and Curriculum Framework]

~~c)~~ ~~direction and measurements of distance on any map or globe; and~~ [Moved to SOL ES.1d and Curriculum Framework]

~~d)~~ ~~location by latitude and longitude and topographic profiles.~~ [Moved to SOL ES.1d and Curriculum Framework]

ES.~~4~~ 3 The student will investigate and understand the characteristics of ~~the~~ Earth and the solar system. Key concepts include

a) position of ~~the~~ Earth in the solar system;
b) sun-Earth-moon relationships (seasons, tides, and eclipses);
c) characteristics of the sun, planets and their moons, comets, meteors, and asteroids; and
d) the history and contributions of ~~the~~ space ~~program~~ exploration.

ES.~~5~~ 4 The student will investigate and understand how to identify major rock-forming and ore minerals based on physical and chemical properties. Key concepts include

a) hardness, color and streak, luster, cleavage, fracture, and unique properties; and
b) uses of minerals.

ES.~~6~~ 5 The student will investigate and understand the rock cycle as it relates to the origin and transformation of rock types and how to identify common rock types based on mineral composition and textures. Key concepts include

a) igneous ~~(intrusive and extrusive)~~ rocks; [Move to Curriculum Framework]
b) sedimentary ~~(clastic and chemical)~~ rocks; and [Move to Curriculum Framework]
c) metamorphic ~~(foliated and unfoliated)~~ rocks. [Move to Curriculum Framework]

ES.~~7~~ 6 The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include

a) fossil fuels, minerals, rocks, water, and vegetation;
b) advantages and disadvantages of various energy sources;
c) resources found in Virginia; and
~~d)~~ ~~making informed judgments related to resource use and its effects on Earth systems; and~~
~~e)~~ d) environmental costs and benefits.

ES.~~8~~ 7 The student will investigate and understand geologic processes including plate tectonics. Key concepts include

~~a)~~ ~~how geologic processes are evidenced in the physiographic provinces of Virginia including the Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau;~~ [Move to Curriculum Framework]

~~b)~~ a) geologic processes ~~(faulting, folding, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation)~~ [Move to Curriculum Framework]and their resulting features; and

~~c)~~ b) tectonic processes ~~(subduction, rifting and sea floor spreading, and continental collision)~~. [Move to Curriculum Framework]

ES.~~9~~ 8 The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include

a) processes of soil development;
b) development of karst topography;
c) ~~identification of~~ relationships between groundwater zones, including saturated and unsaturated zones and the water table~~, zone of saturation, and zone of aeration~~;
d) identification of other sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle;
e) dependence on freshwater resources and the effects of human usage on water quality; and
f) identification of the major watershed systems in Virginia including the Chesapeake Bay and its tributaries.

ES.~~10~~ 9 The student will investigate and understand that many aspects of the history and evolution of ~~the~~ Earth and life can be inferred by studying rocks and fossils. Key concepts include

a) traces and remains of ancient, often extinct, life are preserved by various means in many sedimentary rocks;
b) superposition, cross-cutting relationships, index fossils, and radioactive decay are methods of dating bodies of rock;
c) absolute and relative dating have different applications but can be used together to determine the age of rocks and structures; and
d) rocks and fossils from many different geologic periods and epochs are found in Virginia.

ES.~~11~~ 10 The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include

a) physical and chemical ~~changes~~ characteristics ~~(tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations)~~; [Move to Curriculum Framework]
b) importance of environmental and geologic implications;
c) systems interactions ~~(density differences, energy transfer, weather, and climate)~~; [Move to Curriculum Framework]
d) features of the sea floor ~~(continental margins, trenches, mid-ocean ridges, and abyssal plains)~~ [Move to Curriculum Framework] as reflections of tectonic processes; and
e) economic and public policy issues concerning the oceans and the coastal zone including the Chesapeake Bay.

ES.~~12~~ 11 The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include

a) scientific evidence for atmospheric composition changes over geologic time;
b) current theories related to the effects of early life on the chemical makeup of the atmosphere;
~~c) comparison of the Earth's atmosphere to that of other planets;~~
~~d)~~ c) atmospheric regulation mechanisms including the effects of density differences and energy transfer; and
~~e)~~ d) potential ~~atmospheric compositional~~ changes to the atmosphere and climate due to human, biologic, and geologic activity.

ES.~~13~~ 12 The student will investigate and understand that energy transfer between the sun and ~~the~~ Earth and its atmosphere drives ~~weather and~~ climate on Earth. Key concepts include

a) observation and collection of ~~weather~~ climate data;
b) ~~prediction of weather patterns~~ history of climate change;
c) heat exchange between the ocean and the atmosphere;
~~e)~~ d) severe weather occurrences, such as tornadoes, hurricanes, and major storms; and
~~d)~~ e) weather phenomena and the factors that affect climate including radiation, conduction and convection.

ES.~~14~~ 13 The student will investigate and understand scientific concepts related to the origin and evolution of the universe. Key concepts include

~~a) nebulae~~;
a) cosmology including the Big Bang theory;
b) the origin and evolution of stars ~~and~~, star systems and galaxies~~;~~.
~~c) stellar evolution;~~.
~~d) galaxies; and~~
~~e) cosmology including the big bang theory~~. [Moved to SOL ES.13a]

Biology

The Biology standards are designed to provide students with a detailed understanding of living systems. Emphasis continues to be placed on the skills necessary to examine alternative scientific explanations, actively conduct controlled experiments, analyze and communicate information, and gather and use information in scientific literature. The history of biological thought and the evidence that supports it are explored, providing the foundation for investigating biochemical life processes, cellular organization, mechanisms of inheritance, dynamic relationships among organisms, and the change in organisms through time. The importance of scientific research that validates or challenges ideas is emphasized at this level. All students are expected to achieve the content of the biology standards.

The Biology standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

BIO.1 The student will demonstrate an understanding of scientific reasoning, logic and the nature of science ~~will plan and conduct~~ by planning and conducting investigations in which

a) observations of living organisms are recorded in the lab and in the field;
b) hypotheses are formulated based on direct observations and information from scientific literature;
c) variables are defined and investigations are designed to test hypotheses;
d) graphing and arithmetic calculations are used as tools in data analysis;
e) conclusions are formed based on recorded quantitative and qualitative data;
f) sources of error inherent in experimental design are identified and discussed;
g) validity of data is determined;
h) chemicals and equipment are used in a safe manner;
i) appropriate technology including computers, graphing calculators, and probeware, is used for gathering and analyzing data ~~and~~, communicating results, modeling concepts and simulating experimental conditions;
j) research utilizes scientific literature;
k) differentiation is made between a scientific hypothesis and theory;
l) alternative scientific explanations and models are recognized and analyzed; and
~~m) a scientific viewpoint is constructed and defended (the nature of science).~~
m) current applications of biological concepts are used.

~~BIO.2~~ ~~The student will investigate and understand the history of biological concepts. Key concepts include~~

~~a)~~ ~~evidence supporting the cell theory;~~ [Moved to SOL BIO.3a]

~~b)~~ ~~scientific explanations of the development of organisms through time (biological evolution);~~ [Moved to SOL BIO.7e]

~~c)~~ ~~evidence supporting the germ theory of infectious disease;~~ [Moved to SOL BIO.4f]

~~d)~~ ~~development of the structural model of DNA; and~~ [Moved to SOL BIO.5e]

~~e)~~ ~~the collaborative efforts of scientists, past and present.~~

BIO.~~3~~ 2 The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include

a) water chemistry and its impact on life processes;

b) the structure and function of macromolecules;

c) the nature of enzymes; and

d) the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration.

BIO.~~4~~ 3 The student will investigate and understand relationships between cell structure and function. Key concepts include

a) evidence supporting the cell theory;

~~a)~~ b) characteristics of prokaryotic and eukaryotic cells;

~~b)~~ ~~exploring the diversity and variation of eukaryotes;~~

c) similarities between the activities of the organelles in a single cell and a whole organism; ~~and~~

d) the cell membrane model ~~(diffusion, osmosis, and active transport).~~ ; and [Move to Curriculum Framework]

e) the impact of surface area to volume ratio on cell division, material transport and other life processes.

BIO.~~5~~ 4 The student will investigate and understand life functions of ~~archaebacteria~~, ~~monerans (eubacteria), protists, fungi, plants, and animals including humans~~ archae, bacteria and eukarya. Key concepts include

~~a)~~ ~~how their structures and functions vary between and within the kingdoms.~~

~~b)~~ a) comparison of their metabolic activities;

~~c)~~ ~~analyses of their external and internal responses to the environment;~~

~~d)~~ b) maintenance of homeostasis;

c) how the structures and functions vary among and within the eukarya kingdoms of protists, fungi, plants and animals including humans;

~~e)~~ d) human health issues, human anatomy, and body systems~~, and life functions~~; ~~and~~

~~f)~~ e) how viruses compare with organisms~~.~~; and

f) evidence supporting the germ theory of infectious disease.

BIO.~~6~~ 5 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include

a) cell growth and division;
b) gamete formation;
c) cell specialization;
d) prediction of inheritance of traits based on the Mendelian laws of heredity;
e) historical development of the structural model of DNA;
~~e)~~ f) genetic variation ~~(mutation, recombination, deletions, additions to DNA)~~; [Move to Curriculum Framework]
~~f)~~ g) the structure, function, and replication of nucleic acids ~~(DNA and RNA)~~; [Move to Curriculum Framework]
~~g)~~ h) events involved in the construction of proteins;
~~h)~~ i) use, limitations, and misuse of genetic information; and
~~i)~~ j) exploration of the impact of DNA technologies.

BIO.~~7~~ 6 The student will investigate and understand bases for modern classification systems. Key concepts include

a) structural similarities among organisms;
b) fossil record interpretation;
c) comparison of developmental stages in different organisms;
d) examination of biochemical similarities and differences among organisms; and
e) systems of classification that are adaptable to new scientific discoveries.

BIO.~~8~~ 7 The student will investigate and understand how populations change through time. Key concepts include

a) evidence found in fossil records;
b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations;
c) how natural selection leads to adaptations;
d) emergence of new species; and
e) scientific evidence and explanations for biological evolution.

BIO.~~9~~ 8 The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include

a) interactions within and among populations including carrying capacities, limiting factors, and growth curves;
b) nutrient cycling with energy flow through ecosystems;
c) succession patterns in ecosystems;
d) the effects of natural events and human activities on ecosystems; and
e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems. ~~including the Chesapeake Bay and its tributaries.~~ [Move to Curriculum Framework]

Chemistry

The Chemistry standards are designed to provide students with a detailed understanding of the interaction of matter and energy. This interaction is investigated through the use of laboratory techniques, manipulation of chemical quantities, and problem-solving applications. Scientific methodology is employed in experimental and analytical investigations, and concepts are illustrated with current practical applications that should include examples from environmental, nuclear, organic, and biochemistry content areas.

Technology, including graphing calculators, computers, and probeware, are employed where feasible. Students will understand and use safety precautions with chemicals and equipment. The standards emphasize qualitative and quantitative study of substances and the changes that occur in them. In meeting the chemistry standards, students will be encouraged to share their ideas, use the language of chemistry, discuss problem-solving techniques, and communicate effectively.

The Chemistry standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include

a) designated laboratory techniques;
b) safe use of chemicals and equipment;
c) proper response to emergency situations;
d) manipulation of multiple variables, using repeated trials;
e) accurate recording, organization, and analysis of data through repeated trials;
f) mathematical and procedural error analysis;
g) mathematical manipulations (SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, dimensional analysis);
h) use of appropriate technology including computers, graphing calculators, and probeware, for gathering data ~~and~~ ,communicating results~~;~~ ~~and~~, modeling concepts and simulating experimental conditions;
i) impact of new tools and instruments on increased understanding of nano, atomic and subatomic scales;
~~i)~~ j) construction and defense of a scientific viewpoint ~~(the nature of science).~~; and
k) the use of current applications to reinforce chemistry concepts.

CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of

a) average atomic mass, mass number, and atomic number;
b) isotopes, half lives, and radioactive decay;
c) mass and charge characteristics of subatomic particles;
d) families or groups;
e) series and periods;
f) trends including atomic radii, electronegativity, shielding effect, and ionization energy;
g) electron configurations~~,~~ and valence electrons~~, and oxidation numbers~~;
h) chemical and physical properties; and
i) historical and quantum models.

CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include

a) nomenclature;
b) balancing chemical equations;
c) writing chemical formulas (molecular, structural, and empirical; and Lewis diagrams);
d) bonding types (ionic and covalent);
e) reaction types (synthesis, decomposition, single and double replacement, ~~oxidation-reduction~~, combustion, neutralization, exothermic, and endothermic); and
f) reaction rates~~ and~~, kinetics, and equilibrium. ~~(activation energy, catalysis, and degree of randomness~~). [Move to Curriculum Framework]

CH.4 The student will investigate and understand that chemical quantities ~~in a chemical reaction~~ are based on molar relationships. Key concepts include

a) Avogadro's principle and molar volume;
b) stoichiometric relationships;
~~c)~~ ~~partial pressure;~~ [Moved to SOL CH.5b]
~~d)~~ ~~gas laws;~~ [Moved to SOL CH.5b]
~~e)~~ c) solution concentrations; and
~~f)~~ ~~chemical equilibrium; and~~ [Moved to SOL CH.3f]
~~g)~~ d) acid/base theory; strong electrolytes, weak electrolytes, and nonelectrolytes; dissociation and ionization; pH and pOH; and the titration process.

CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include

a) pressure, temperature, and volume;
b) partial pressure and gas laws;
~~b)~~ c) vapor pressure;
~~c)~~ d) phase changes;
~~d)~~ e) molar heats of fusion and vaporization;
~~e)~~ f) specific heat capacity; and
~~f)~~ g) colligative properties.

CH.6 The student will investigate and understand how basic chemical properties relate to other areas of chemistry. Key concepts include

a) organic chemistry; and

b) biochemistry.

Physics

The Physics standards emphasize a more complex understanding of experimentation, the analysis of data, and the use of reasoning and logic to evaluate evidence. The use of mathematics, including algebra and trigonometry, is important, but conceptual understanding of physical systems remains a primary concern. Students build on basic physical science principles by exploring in depth the nature and characteristics of energy and its dynamic interaction with matter. Key areas covered by the standards include force and motion, energy transformations, wave phenomena and the electromagnetic spectrum, ~~light,~~ electricity, fields, and non-Newtonian physics. The standards stress the practical application of physics in other areas of science and its application to technology, engineering, and mathematics. ~~and how~~ The effects of physics ~~affects~~ on our world are investigated through the study of critical, contemporary global topics.

The Physics standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

PH.1 The student will plan and conduct investigations using experimental design and product design processes. ~~in which~~ Key concepts include

- a) the components of a system are defined;
- b) instruments are selected and used to extend observations and measurements ~~of mass, volume, temperature, heat exchange, energy transformations, motion, fields, and electric charge~~; [Move to Curriculum Framework]
- c) information is recorded and presented in an organized format;
- ~~d) metric units are used in all measurements and calculations;~~
- ~~e)~~ d) the limitations of the experimental apparatus and design are recognized;
- ~~f)~~ e) the limitations of measured quantities are recognized through the appropriate use of significant figures or error ranges;
- ~~g) data gathered from non-SI instruments are incorporated through appropriate conversions; and~~
- f) models and simulations are used to visualize and explain phenomena, to make predictions from hypotheses and to interpret data; and
- ~~h)~~ g) appropriate technology, including computers, graphing calculators, and probeware, is used for gathering and analyzing data and communicating results.

PH.2 The student will investigate and understand how to analyze and interpret data. Key concepts include

- a) a description of a physical problem is translated into a mathematical statement in order to find a solution;
- b) relationships between physical quantities are determined using the shape of a curve passing through experimentally obtained data;
- c) the slope of a linear relationship is calculated and includes appropriate units;
- d) interpolated, extrapolated, and analyzed trends are used to make predictions; and
- e) ~~analysis of systems employs~~ situations with vector quantities are analyzed utilizing trigonometric ~~and~~ or graphical methods.

PH.3 The student will investigate and understand how to demonstrate scientific reasoning and logic. Key concepts include

a) analysis of scientific sources to develop and refine research hypotheses;
b) analysis of how science explains and predicts relationships;
c) evaluation of evidence for scientific theories;
d) examination of how new discoveries result in modification of existing theories or establishment of new paradigms; and
e) construction and defense of a scientific viewpoint (the nature of science).

PH.4 The student will investigate and understand how applications of physics affect the world. Key concepts include

a) examples from the real world; and
b) exploration of the roles and contributions of science and technology.

PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include

a) linear motion;
b) uniform circular motion;
c) projectile motion;
d) Newton's laws of motion;
e) gravitation;
f) planetary motion; and
g) work, power, and energy.

PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved. Key concepts include

a) kinetic and potential energy;
b) elastic and inelastic collisions; and
~~c)~~ ~~electric power~~. [Moved to SOL PH.13]
c) mass/energy equivalence.

~~PH.7~~ ~~The student will investigate and understand properties of fluids. Key concepts include~~

~~a)~~ ~~density and pressure;~~
~~b)~~ ~~variation of pressure with depth;~~
~~c)~~ ~~Archimedes' principle of buoyancy;~~
~~d)~~ ~~Pascal's principle;~~
~~e)~~ ~~fluids in motion; and~~
~~f)~~ ~~Bernoulli's principle.~~

PH.~~8~~ 7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include

a) transformation of energy among forms including mechanical, thermal, ~~electrical~~, gravitational, electromagnetic, chemical, and nuclear; and
b) efficiency of systems.

PH.~~9~~ 8 The student will investigate and understand ~~how to use models of transverse and longitudinal waves to interpret~~ wave phenomena. Key concepts include

a) wave characteristics ~~(period, wavelength, frequency, amplitude, and phase~~); [Move to Curriculum Framework]

b) fundamental wave processes ~~(reflection, refraction, diffraction, interference, polarization, Doppler effect)~~; and [Move to Curriculum Framework]

c) light and sound in terms of wave models.

PH.~~10~~ 9 The student will investigate and understand that different frequencies and wavelengths in the electromagnetic spectrum are phenomena ranging from radio waves through visible light to gamma radiation. Key concepts include

a) the properties and behaviors and relative size of radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays; ~~and~~

b) particle nature of light; and

~~b)~~ c) current applications based on the ~~wave properties of each band~~ relative wavelengths.

~~PH.11~~ ~~The student will investigate and understand, in describing optical systems, how light behaves in the fundamental processes of reflection, refraction, and image formation. Key concepts include~~

~~a) application of the laws of reflection and refraction;~~

~~b) construction and interpretation of ray diagrams;~~

~~c) development and use of mirror and lens equations; and~~

~~d) predictions of type, size, and position of real and virtual images.~~

PH.~~12~~ 10 The student will investigate and understand how to use the field concept to describe the effects of gravitational, electric, and magnetic forces. Key concepts include

a) inverse square laws (Newton's law of universal gravitation and Coulomb's law); and

b) ~~operating principles of motors, generators, transformers, and cathode ray tubes~~ technological applications.

PH.~~13~~ 11 The student will investigate and understand how to diagram ~~and~~, construct, and analyze basic electrical circuits and explain the function of various circuit components. Key concepts include

a) Ohm's law;

b) series, parallel, and combined circuits; ~~and~~

c) ~~circuit components including resistors, batteries, generators, fuses, switches, and capacitors.~~ electrical power; and

d) alternating and direct currents.

PH.~~14~~ 12 The student will investigate and understand that extremely large and extremely small quantities are not necessarily described by the same laws as those studied in Newtonian physics. Key concepts may include

a) wave/particle duality;
b) wave properties of matter;
c) matter/energy equivalence;
d) quantum mechanics and uncertainty;
e) relativity;
f) nuclear physics;
g) solid state physics;
h) nanotechnology;
~~h)~~ i) superconductivity; and
~~i)~~ j) radioactivity.

Board of Education Agenda Item

Item: K. **Date:** October 22, 2009

Topic: First Review of the 2008-2009 Annual Report on Regional Alternative Education Programs

Presenter: Ms. Diane L. Jay, Associate Director, Office of Program Administration and Accountability

Telephone Number: (804) 225-2905 **E-Mail Address:** Diane.Jay@doe.virginia.gov

Origin:

_____ Topic presented for information only (no board action required)

_X_ Board review required by
- _X_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

_X_ Action requested at this meeting ____ Action requested at future meeting:

Previous Review/Action:

_X_ No previous board review/action

____ Previous review/action
date _____
action _____

Background Information: Section 22.1-209.1:2 of the *Code of Virginia* requires that the Board of Education provide an annual report to the Governor and the General Assembly on the effectiveness of the Regional Alternative Education Programs. The 1993 General Assembly approved legislation and funding to create regional pilot programs to provide an educational alternative for certain students who have a pending violation of school board policy, have been expelled or suspended on a long-term basis, or are returning from juvenile correctional centers. A formula based on staffing patterns and the composite index of local ability-to-pay determines continuation funding for the programs.

Summary of Major Elements: One hundred seventeen (117) school divisions participate in the regional alternative education programs. During 2008-2009, 4,085 students were served. An annual report that summarizes the status and effectiveness of the regional programs is attached.

Superintendent's Recommendation: The Superintendent of Public Instruction recommends that the Board of Education waive first review and approve the 2008-2009 Annual Report on Regional Alternative Education Programs pursuant to §22.1-209.1:2, *Code of Virginia*.

Impact on Resources: None.

Timetable for Further Review/Action: Following approval, the report will be forwarded to the Governor and the General Assembly as required by §22.1-209.1:2, *Code of Virginia*.

VIRGINIA BOARD OF EDUCATION

2008-2009 Annual Report

REGIONAL ALTERNATIVE EDUCATION PROGRAMS

PRESENTED TO

GOVERNOR TIMOTHY M. KAINE
AND THE
VIRGINIA GENERAL ASSEMBLY

October 22, 2009

PREFACE

Section 22.1-209.1:2 of the *Code of Virginia* requires that a report be provided annually by the Board of Education to the Governor and the General Assembly on the effectiveness of the Regional Alternative Education Programs. The primary objectives of this report are as follows:

1. Provide a general overview of the programs, student populations, staff, program resources and support, and parental and community support.
2. Review the program administrators' perceptions of the adequacy of the programs.
3. Evaluate the performance of the programs and students.

The staff member assigned to the preparation of the report was Diane L. Jay, associate director, Office of Program Administration and Accountability, Division of Instruction, Virginia Department of Education, P. O. Box 2120, Richmond, Virginia 23218-2120. Questions concerning the report should be directed to Ms. Jay at (804) 225-2905 or by e-mail at Diane.Jay@doe.virginia.gov.

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2008-2009 ANNUAL REPORT ON REGIONAL ALTERNATIVE EDUCATION PROGRAMS

EXECUTIVE SUMMARY

The review was conducted on Virginia's 30 operational regional alternative education programs. These programs were established by the General Assembly in 1993-1994 with the intent of involving two or more school divisions working in collaboration to establish options for students who have a pending violation of school board policy, have been expelled or suspended on a long-term basis, or are returning from juvenile correctional centers. Section 22.1-209.1:2 of the *Code of Virginia* requires that a report be provided annually by the Board of Education to the Governor and the General Assembly on the effectiveness of the regional alternative education programs.

These regional alternative education programs are designed to meet the specific individual needs of students assigned to the programs. While there is some variation in programs, the legislation outlines the following components:

- an intensive, accelerated instructional program with rigorous standards for academic achievement and student behavior;
- a low pupil-teacher ratio to promote a high level of interaction between the student and teacher;
- a plan for transitioning the enrolled students into the relevant school division's regular program;
- a current program of staff development and training;
- a procedure for obtaining the participation and support from parents as well as community outreach to build school, business, and community partnerships; and
- measurable goals and objectives and an evaluation component to determine the program's effectiveness.

The number of students enrolled has increased from 217 students in four regional programs in 1993-1994 to 4,085 students in 30 operational programs during 2008-2009. Conclusions related to the program, services, and policies for the 2008-2009 school year are as follows:

- 97 percent of the program administrators indicate that school boards, localities, and area agencies generally offer good or excellent support;
- 97 percent of program administrators reported a good or excellent rating for technology and staff development programs;
- 90 percent of program administrators reported a good or excellent rating for discipline policies, student services, and academic programs;
- 89 percent of program administrators reported a decrease or no change in violence, firearms, and weapons possession incidences for students while in the program as well as a decrease in substance abuse and property offenses;
- 73 percent of program administrators reported academic improvement in their responses regarding perceived changes in student academic performance;
- 67 percent of program administrators reported good or excellent support from community involvement;

- 63 percent of program administrators reported a good or excellent rating for parental involvement;
- 47 percent of program administrators reported good or excellent support from the business community;
- of the 272 teachers employed, 249 (or 92 percent) are licensed;
- the average student-to-teacher ratio was 11:1;
- Standards of Learning (SOL) assessments in English and mathematics were taken by 2,543 alternative education students during the 2008-2009 school year. These students achieved a 61 percent pass rate on the English SOL and a 47 percent pass rate on the mathematics SOL;
- the dropout rate for these students is 5.83 percent. The expulsion or dismissal rate is 7.27 percent;
- of the students who were not eligible to graduate in the 2008-2009 school year and who did not dropout or were not expelled or dismissed, 72.6 percent remained in school at the end of the 2008-2009 school year; and
- of the students that were eligible to graduate from high school, 84.9 percent graduated at the end of the 2008-2009 school year.

CHAPTER ONE

Purpose

Virginia's regional alternative education programs are established to provide options for students who no longer have access to traditional school programs because they were suspended for violations of school board policy. Assignment to these programs include violations related to weapons, drugs or alcohol, intentional injury, chronic disruptive behavior, theft, verbal threats, malicious mischief, chronic truancy, vandalism, and other serious offenses. These programs also accommodate students returning from juvenile correctional centers or those who are otherwise assigned by the school divisions.
There are 30 regional programs. A total of 117 school divisions worked in collaboration to form the 30 programs; some of the divisions have multiple subprograms and sites. A listing of the programs and participating school divisions is provided in Attachment A1.

Objectives and Scope of Evaluation

Section 22.1-209.1:2 of the *Code of Virginia* requires that a report be provided annually by the Board of Education to the Governor and the General Assembly on the effectiveness of the regional alternative education programs. The primary objectives of this report are as follows:

1. provide a general overview of the programs, student populations, staff, program resources and support, and parental and community support;
2. review the program administrators' perceptions of the adequacy of the programs; and
3. evaluate the performance of the programs and students.

The goals of the 30 operational regional alternative education programs are similar in that they are all designed to provide alternative and experiential learning opportunities for the students they serve. They serve students who have been assigned to the school by a local board of education because the alternative education programs can provide a wide variety of student services and educational approaches that are tailored to their needs. While the general goals among programs are similar, there are also differences such as:

- grade levels served;
- size of the student bodies;
- characteristics of the students enrolled;
- characteristics of the student enrollment expectations (e.g., very short-term versus long-term);
- educational approaches and priorities; and
- program resources available.

Data Sources

The information, observations, and findings in this summary report are primarily based on the following sources:

- Information collected by the Virginia Department of Education through an annual data collection instrument and supplemental information provided with these reports. In June 2009, the reports were submitted by each of the programs for the 2008-2009 school year.
- Follow-up communications with program administrators and personnel.
- Relevant information included in previous regional alternative education program evaluations published by the Virginia Department of Education.

CHAPTER TWO

Background and Summary Information

In 1993, the General Assembly directed the Board of Education to establish and implement four regional pilot projects to provide an educational alternative for certain students in violation of school board policy. The General Assembly subsequently provided state funding, augmented for several years by federal funds, to make regional alternative education programs available on a statewide basis. A Virginia Department of Education formula based on staffing patterns and the composite index of local ability-to-pay determines state funding. No local matching funding is required; however, local school divisions sometimes use local and federal monies to augment these programs by providing in-kind support for such items as instructional materials, additional staff, pupil transportation, and facilities.

Alternative education programs are designed to meet the specific individual needs of students assigned to the programs. While there is some variation in programs, the legislation outlines the following components:

- an intensive, accelerated instructional program with rigorous standards for academic achievement and student behavior;
- a low pupil-teacher ratio to promote a high level of interaction between the student and teacher;
- a plan for transitioning the enrolled students into the relevant school division's regular program;
- a current program of staff development and training;
- a procedure for obtaining the participation and support from parents as well as community outreach to build school, business, and community partnerships; and
- measurable goals and objectives and an evaluation component to determine the program's effectiveness.

The delivery of services includes traditional and nontraditional forms of classroom instruction, distance learning, and other technology-based educational approaches. Delivery of services also includes day, afterschool, and evening programs. Alternative education centers have flexibility with regard to their organizational structure, schedule, curriculum, programs, and disciplinary policies. While the centers may differ in method of delivery, the services they provide typically fall into the following categories:

- educational (core subject instruction, vocational, remediation, tutoring);
- counseling (individual, group, family);
- social skills training;
- career counseling (transitioning to the world of work, job shadowing, mentoring, work/study agreements);
- technology-related education (direct instruction, Internet research, keyboarding);
- conflict resolution and mediation; and
- drug prevention education.

CHAPTER THREE

Regional Alternative Education Program Overview

This chapter provides an overview of program and student trends, program purposes, organization, innovative practices, reasons for student enrollment, student selection processes, academic offerings, student services, student assessments, and general and discipline policies of the regional alternative education programs.

A. Characteristics of Programs and Student Population

Statistical Overview – Twenty-four programs serve both middle and secondary students. Five programs serve only secondary students, and one program serves middle school students exclusively. Additionally, 73 percent of the programs report serving General Educational Development (GED) certificate students.

The programs report having 1,822 assigned state slots and serving 4,085 students during the 2008-2009 school year. Since students are assigned for short periods of time in some programs (e.g., several weeks in some cases), multiple students can be served per slot. Several programs have expanded using local funds in order to include more students.

Over the first four years of Virginia's regional alternative education program, the number of programs grew rapidly from the four pilot sites in 1993-1994 to 29 programs by 1996-1997. Since that time, the number of programs has remained relatively constant. A new regional program was approved by the General Assembly in 2000-2001 bringing the number of programs to 30. In 2003-2004, one regional program dissolved, thus reducing the number of programs to 29. In 2007-2008, three school divisions withdrew from one of the regional programs to form a new regional program; however, the new regional program did not become operational until 2008-2009.

State funding increased from the initial General Assembly appropriation of $1.2 million for 1993-1994 to a total state funding level of slightly over $6.7 million for 2008-2009. Programs are permitted to receive additional funding and in-kind support from other sources although no local match is required. No additional state funding was required for the new program. Rather, funding was based on the number of slots already available to the three school divisions.

The number of students enrolled increased from 217 students in four regional programs in 1993-1994 to 4,085 students in the 30 operational regional programs in 2008-2009.

Table 1 summarizes trends for the number of regional alternative education programs in Virginia, state funding levels for these programs, and numbers of students served since the 1993-1994 school year.

Table 1.
Trends in Regional Alternative Education Programs

School Year	Number of Operational Programs or Sites [1]	State Funding [2]	Number of Students Served
1993-1994	4	$1,200,000	217
1994-1995 [2]	13	$1,200,000	849
1995-1996 [2]	19	$1,200,000	1,550
1996-1997	29	$4,142,000	2,297
1997-1998	29	$3,716,652	2,350
1998-1999	29	$4,431,089	3,255
1999-2000	29	$4,484,123	3,494
2000-2001	30	$5,766,626	3,347
2001-2002	30	$5,386,590	3,895
2002-2003	30	$5,386,590	3,509
2003-2004	29	$5,210,891	3,534
2004-2005	29	$5,486,348	3,903
2005-2006	29	$5,561,410	4,155
2006-2007	29	$6,220,518	4,205
2007-2008	29	$6,765,069	4,002
2008-2009	30	$6,717,848	4,085

Note [1]: Some data refer to sites and some refer to programs.
Note [2]: Federal funds were used to supplement state funds to expand the program during the 1994-1995 and 1995-1996 school years.

Students Served by Demographics – For 2008-2009, Table 2 summarizes the ethnicity of students.

Table 2.
Ethnicity

Ethnicity	Total	Percent
White	2,149	52.61%
African-American	1,681	41.15%
Hispanic	206	5.04%
Asian/Pacific Islander	15	0.37%
American Indian/Alaskan Native	4	0.1%
Unspecified/Other	30	0.73%
Total	4,085	100%

Students Served by Gender – Table 3 summarizes the gender of students in the regional programs for 2008-2009. The majority of students were males.

Table 3.
Gender

Gender	Total	Percent
Male	2,907	71.16%
Female	1,178	28.84%
Total	4,085	100%

Students Served by Age – For 2008-2009, Table 4 reflects the age of students at the time of placement in the alternative program. A majority of students are placed in programs between the ages of 12 and 18, with the highest number of placements for students between the ages of 14 and 17.

Table 4.
Age at Placement

Age	Number of Students
9	0
10	0
11	38
12	186
13	343
14	562
15	750
16	893
17	914
18	345
19	51
20	2
21	1
22	0
Total	4,085

Grade Level Placement of Students – Table 5 shows the grade level at time of placement. The greatest numbers of students are placed in the regional alternative programs between grade 8 and grade 10.

Table 5.
Grade Level at Placement

Grade	Number of Students
Grade 2	0
Grade 3	0
Grade 4	2
Grade 5	11
Grade 6	132
Grade 7	374
Grade 8	631
Grade 9	1,049
Grade 10	810
Grade 11	486
Grade 12	521
Ungraded	69
Total	4,085

Program Purpose – The regional alternative education programs are designed to meet the specific individual needs of students assigned to the programs. These needs dictate a different set of "program purposes" or objectives than would be encountered in the traditional school system. Administrators were asked to identify the objectives most

appropriate for the various sites operating within their programs. The "program purposes" reported by the majority of programs are to:

- reduce the dropout rate;
- build self-esteem and responsibility;
- correct dysfunctional and/or dangerous behavior;
- return students to the sending high school to continue their education and graduate; and
- identify career interests.

Program Organization – The programs included in this evaluation reflect a wide variety of educational, operational models, and processes. Most programs report operating between 9 and 12 months a year, but the average is 10 months. Full-day programs are offered in 60 percent of the programs. Morning and evening classes are offered in 37 percent of the programs. For 80 percent of the programs, classes are organized by subject or course, and 57 percent organize classes by grade level. Programs report that 57 percent of their students work independently on computer-based curricula.

Reasons for Student Enrollment and Student Selection Process – Students are typically assigned to regional alternative education programs because they have received long-term suspensions, are returning from juvenile correctional centers, or are otherwise identified by the school divisions to be best served by these programs. Consequently, these programs are structured to address the special needs of these students. Table 6 provides insight as to the primary reasons leading to student enrollments for the 2008-2009 school year.

Table 6.
Reasons for Enrollment in Regional Alternative Education Programs 2008-2009

Reasons for Enrollment	Total	Percent
Suspensions for violation of School Board Policy [2]	3,094	75.74[1]
Chronic Disruptive Behavior	934	30.19 [3]
Drugs or alcohol	504	16.29[3]
Intentional Injury	263	8.5[3]
Weapons	164	5.3[3]
Theft	24	0.78[3]
Combination of above	302	9.76[3]
Other [4]	903	29.19[3]
Released from youth correctional centers	124	3.04[1]
Other(explain)	867	21.22[1]
Total Suspensions and Released from Youth Correctional Centers	**4,085**	**100**

Note [1]: Percentage of 4,085 (the total number of students served).
Note [2]: Included pending violations.
Note [3]: Percentage of 3,094 (the total number of students suspended for violation of school board policy).
Note [4]: Verbal threats, malicious mischief, bomb threats, destruction of property, chronic truancy, vandalism, and other serious offenses.

There is no standardized student selection process. The student selection process includes guidelines and criteria for admittance. The denial of admission varies from program to program. Generally, the programs report that students were assigned to them "as a last chance option." All of the program administrators report that parent orientation is offered, and 83 percent state that they offer parent-student-school contracts.

Academic Offerings and Student Services – An intense, accelerated instructional program with rigorous standards for academic achievement and student behavior is a legislative requirement of the regional alternative education programs. The range of students served and academic approaches used produce a wide spectrum of courses offered, academic initiatives, and student services. At a general level, there are many core academic offerings and student services common to these regional alternative education programs. Standard diploma courses are offered in 28 programs. About 73 percent of these programs also offer GED preparatory courses; 60 percent offer vocational coursework; 60 percent offer independent study; and 33 percent offer work study components.

Student Assessments – Other legislative requirements for these programs include a set of measurable goals and objectives and an evaluation component to determine student performance and program effectiveness. In this context, 97 percent of the programs report employing traditional evaluations (e.g., an A, B, C, D, and F letter grading system, and end-of-year examinations) for all students enrolled. Nontraditional evaluations (e.g., oral presentations, portfolios, self-assessments, grading rubrics shared in advance, and maintaining appropriate behavior) are also used for 80 percent of students. About 77 percent of the programs use a combination of traditional and nontraditional approaches to evaluate their students.

B. Staff

Program Staffing – Administrators of the 30 programs reported a total of 272 teachers (in full-time equivalents). Of that number, 249 or 92 percent are licensed. A low pupil-to-teacher ratio is a legislative requirement for these programs. In 2008-2009, the average student-to-teacher ratio was 11:1.

Professional Development – Professional development is another legislative requirement for this program. The extensive and diverse special needs and challenges of the students assigned to the regional alternative education programs present additional needs for staff development.

Improving and expanding staff development is frequently mentioned as a primary goal of program administrators. The staff development offerings include: 1) a broad spectrum of professional development related to content areas; 2) use of technology; 3) programmatic and administrative issues; and 4) a broader spectrum of behavioral problems common to the students served.

C. Program Support

External Program Support – A program for community outreach to build school, business, and community partnerships is a legislative component of the regional alternative education programs. All programs report extensive efforts to build external support, and the program administrators report that they generally receive very good external support.

Administrators report that their school boards, localities, and area agencies generally provide good support. Ninety-seven (97) percent of the program administrators indicate that these sources offer "excellent" or "good" support.

D. Parental and Community Involvement

Parental and Community Involvement – A procedure for obtaining the participation and support from parents and community is a legislative requirement of the regional alternative education program. Each program reported initiatives addressing these objectives. Of the responding administrators, 13.3 percent reported that parental involvement in their program is "excellent"; 50 percent reported "good" parental involvement; 23.3 percent reported "fair" parental involvement; and 13.3 percent reported that the parental involvement in their program was "poor." Of the responding administrators, 47 percent reported "excellent" or "good" support and 53 percent reported "fair" support from the business community. Of the responding administrators, 67 percent reported "excellent" or "good" support from community involvement, and 33 percent responded "fair" support.

CHAPTER FOUR

Program and Student Performance

Defining and measuring performance are different for the alternative education population than it would be in the traditional school systems.

A. Considerations for Evaluating Regional Alternative Education Programs and Student Performance

The student populations in the regional alternative education programs present challenges because the assigned students often have histories of behavioral problems, low self-esteem, and academic failure. Since these are generally students who have been suspended, these programs are deemed as the only remaining academic option. Most programs report that students are placed or assigned to their program as "a last chance option."

The student body of any given program has less continuity from year to year (often from month to month) than a traditional school. Programs are generally small and address an array of needs. The combination of these needs and the operational constraints of the programs dictate different policies, administrative procedures, and academic approaches. They also dictate a different approach to evaluating both program and student performance. One approach for assessing program and student performance is the programs' self-reported "program purposes" as presented in Chapter One. These include:

- reduce the dropout rate;
- build self-esteem and responsibility;
- correct dysfunctional and/or dangerous behavior;
- return students to high school to graduate;
- identify career interests;
- gain admission to an institution of higher education;
- secure employment or work/study;
- obtain diploma from sending school in absentia; and
- earn a General Educational Development (GED) certificate through an Individual Student Alternative Education Plan (ISAEP).

B. Measures of Achievement

It is difficult to consider standard measurements such as Standards of Learning (SOL) tests, attendance, and dropout rates in the same way as they would be considered for traditional schools because the student populations, educational models, and operational models are different.

Standards of Learning – The ability to report SOL test results for students who were served in a regional alternative education program was available for the first time in the 2005-2006 school year. The figures for 2005-2006 through 2008-2009 are reported in Table 7. There were 2,543 alternative education students who took the Standards of Learning tests in English and mathematics in 2008-2009. These students achieved a 61 percent pass rate on the English SOL and a 47 percent pass rate on the mathematics SOL for 2008-2009. The data provided do not represent cohort data because students move in and out of these programs.

Table 7.
Standards of Learning Assessment Results in English and Mathematics [1]

Year	Students Taking SOL Tests	English Pass Rate Percentage	Mathematics Pass Rate Percentage
2005-2006	1,762	32	19
2006-2007	1,916	48	33
2007-2008	2,011	52	38
2008-2009	2,543	61	47

Note [1]: These assessment results reflect students who were in the regional alternative program during test administration.

Annual Event Dropout/Dismissal Rates –The total 2008-2009 dropouts reported by the program administrators for this report was 5.83 percent. The state average event dropout rate for traditional schools in 2007-2008 was 1.89 percent. Event dropout rates for 2008-2009 will be available from the Virginia Department of Education after November 15, 2009. Most regional alternative education students are considered dropout risks prior to being assigned to these programs. The expulsion/dismissal rate for 2008-2009 was 7.27 percent. Table 8 reflects these figures.

Table 8.
Dropped Out or Expelled

Students Who Did Not Remain in School While in a Regional Alternative Education Program	Percentage
Dropped Out	5.83
Expelled or dismissed from alternative education program and did not return to another school	7.27

Perceptions of Changes in Student Academic Performance – Administrators were asked to provide their perceptions of changes in their students' academic performance. The administrators perceived somewhat or substantial improvement in approximately 73 percent of students served.

Table 9.
Reported Perceptions of Change in Academic Performance

Reported Change During Assignment to Alternative Education	Substantially Improved	Somewhat Improved	Somewhat Decreased	Substantially Decreased	No Apparent Change	Total Responses
Middle Grades – Mathematics	10.0%	60.0%	10.0%	0.0%	20.0%	30
Middle Grades – English	16.7%	56.7%	0.0%	0.0%	26.7%	30
High School – Mathematics	13.3%	53.3%	13.3%	0.0%	20.0%	30
High School – English	33.3%	46.7%	0.0%	0.0%	20.7%	30

Perceptions of Changes in Student Disciplinary Incidences – Correcting behavior is a primary goal of regional alternative education programs. Table 10 reflects the administrator perceptions of changes in student disciplinary incidences while students are in the program.

Table 10.
Reported Perceptions of Change in Disciplinary Performance

Reported Change During Assignment to Alternative Education	Substantially Decreased	Somewhat Decreased	No Apparent Change	Somewhat Increased	Substantially Increased	Total Responses
Physical Violence (Serious Incidents)	26.7%	36.7%	30.0%	6.7%	0.0%	30
Other Physical Violence	26.7%	33.3%	40.0%	0.0%	0.0%	30
Firearms Related Violations	20.0%	30.0%	40.0%	10.0%	0.0%	30
Substance Abuse	6.7%	43.3%	30.0%	13.3%	6.7%	30
Offences Against Property	10.0%	33.3%	36.7%	20.0%	0.0%	30

End-of-Year Status of 2008-2009 Students – Data discussed previously in this report suggest that many of the students that the programs served in 2008-2009 were assigned as a final alternative. Most of these students were at risk of dropping out, being expelled permanently, or failing academically. Some had already been incarcerated. Based on these data, approximately 72.6 percent of students served in the 2008-2009 regional alternative education programs remain in school, either returning to the regional alternative program for 2009-2010, or returning to their sending school for 2009-2010. For this population, remaining in school is an accomplishment and a stated goal of the regional alternative education programs. Of the remaining students, 5.8 percent dropped out of school; 7.3 percent were expelled; and 14.3 percent listed other reasons for leaving the program which included graduating from high school, earning a GED, or transferring to another school division. Of the students that were eligible to graduate from high school, 84.9 percent graduated at the end of the 2008-2009 school year. Overall, the regional alternative education programs appear to be achieving their program purposes.

ATTACHMENTS

Attachment A1

Listing of Regional Alternative Education Programs – 2008-2009

Table A1.
Regional Alternative Education Programs – 2008-2009

School Division-Fiscal Agent	Other Participating Divisions	Program Name
Bristol City Public Schools	Washington County Public Schools	Crossroads Alternative Education Program
Brunswick County Public Schools	Greensville County and Mecklenburg County Public Schools	Southside LINK
Buena Vista City Public Schools	Rockbridge County and Lexington City Public Schools	Regional Alternative Education Program
Carroll County Public Schools	Galax City Public Schools	Carroll-Galax Regional Alternative Education Program (The RAE Center)
Fairfax County Public Schools	Alexandria City Public Schools	Transition Support Resource Center
Fauquier County Public Schools	Rappahannock County Public Schools	The Regional Continuum of Alternative Education Services
Fluvanna County Public Schools	Alleghany County, Bath County, Botetourt County, Charles City County, Clarke County, Craig County, Culpeper County, Floyd County, Franklin County, Giles County, Grayson County, Greene County, Halifax County, Highland County, Madison County, Orange County, Shenandoah County, and Smyth County Public Schools, Radford City Public Schools	Project RETURN
Henry County Public Schools	Martinsville City and Patrick County Public Schools	Breaking Barriers
King William County Public Schools	Gloucester County, Mathews County, Middlesex County, Essex County, King and Queen County, and New Kent County Public Schools, Town of West Point Public Schools	Middle Peninsula Regional Alternative Education Program
Lynchburg City Public Schools	Appomattox County, Amherst County, Bedford County, and Nelson County Public Schools	Regional Alternative Education Project
Montgomery County Public Schools	Pulaski County Public Schools	Regional Program for Behaviorally Disturbed Youths

School Division-Fiscal Agent	Other Participating Divisions	Program Name
Newport News City Public Schools	Hampton City Public Schools	Enterprise Academy
Norfolk City Public Schools	Chesapeake City, Franklin City, Suffolk City, and Virginia Beach City Public Schools, Isle of Wight County and Southampton County Public Schools	Southeastern Cooperative Education Program
Northampton County Public Schools	Accomack County Public Schools	Project Renew
Nottoway County Public Schools	Amelia County, Buckingham County, Charlotte County, Cumberland County, Lunenburg County, and Prince Edward County Public Schools	Piedmont Regional Alternative School
Petersburg City Public Schools	Dinwiddie County, Prince George County, and Sussex County Public Schools, Colonial Heights City and Hopewell City Public Schools	Bermuda Run Educational Center Regional Alternative Program
Pittsylvania County Public Schools	Danville City Public Schools	Pittsylvania County/Danville City Regional Alternative School
Powhatan County Public Schools	Goochland County and Louisa County Public Schools	Project Return Regional Alternative Education Program
Prince William County Public Schools	Manassas City and Manassas Park City Public Schools	New Dominion Alternative School
Richmond City Public Schools	Hanover County and Henrico County Public Schools	Metro-Richmond Alternative Education Program
Roanoke City Public Schools	Salem City Public Schools	Roanoke/Salem Regional
Roanoke County Public Schools	Bedford County Public Schools	R. E. Cook Regional Alternative School
Russell County Public Schools	Tazewell County Public Schools	Project BRIDGE
Scott County Public Schools	Lee County Public Schools	Renaissance Program

School Division-Fiscal Agent	Other Participating Divisions	Program Name
Stafford County Public Schools	Caroline County, King George County, and Spotsylvania County Public Schools, and Fredericksburg City Public Schools	Regional Alternative Education Program
Staunton City Public Schools	Harrisonburg City and Waynesboro City Public Schools, and Augusta County Public Schools	Genesis Alternative School
Westmoreland County Public Schools	Lancaster County, Northumberland County and Richmond County Public Schools, Town of Colonial Beach	Northern Neck Regional Alternative Education Program
Wise County Public Schools	Dickenson County Public Schools and Norton City Public Schools	Regional Learning Academy
Wythe County Public Schools	Bland County Public Schools	Wythe/Bland Alternative Education Program
York County Public Schools	Poquoson City and Williamsburg-James City County Public Schools	Three Rivers Project-Enterprise Academy

Attachment A2

***Code of Virginia* Citation for Alternative Education Programs for Certain Students**

§ 22.1-209.1:2. Alternative education programs for certain students.

A. With such funds as may be appropriated for this purpose, the Board of Education shall establish a program consisting of alternative education options for elementary, middle, and high school students in compliance with subdivision D 6 of § 22.1-253.13:1 who (i) have committed an offense in violation of school board policies relating to weapons, alcohol or drugs, or intentional injury to another person, or against whom a petition or warrant has been filed alleging such acts or school board charges alleging such policy violations are pending; (ii) have been expelled from school attendance or have received one suspension for an entire semester, or have received two or more long-term suspensions within one school year; or (iii) have been released from a juvenile correctional center and have been identified by the Superintendent of the Department of Correctional Education and the relevant division superintendent as requiring an alternative education program. However, no child shall be assigned to any alternative education program described in this section for more than one school year without an annual assessment of the placement to determine the appropriateness of transitioning the child into the school division's regular program. On and after July 1, 1994, the program shall consist of up to 10 regional pilot projects; any additional pilot projects shall be located in regions throughout the state to provide greater geographical distribution of such projects. All such projects shall be awarded on a competitive basis to applicants responding to requests for proposals, giving priority in awarding any new sites, to the extent practicable, to applicants in areas with high student suspension and expulsion rates that meet the requirements in subsection B of this section. The Board of Education shall promulgate regulations for the implementation of the program.

B. Upon the appropriation of funds for the purposes of this section, the Department of Education shall issue a request for proposals for regional projects to pilot selected alternative education options by July 1, 1993. The first such grants shall be awarded by August 20, 1993.

In the 2001 fiscal year, and upon the appropriation of funds for these purposes, the Department of Education shall issue a request for proposals for regional pilot projects for selected alternative education options for elementary school students. The first such grants shall be awarded by September 1, 2001.

Applications for grants shall include the following components:

1. An agreement executed by two or more school divisions and approval of their respective governing bodies to pilot an alternative education option as provided in subsection A, and a plan for the apportionment of responsibilities for the administration, management, and support of the program, including, but not limited to, the facilities and location for the program, daily operation and oversight, staffing, instructional materials and resources, transportation, funding and in-kind services, and the program of instruction.

2. A procedure for obtaining the participation in or support for the program, as may be determined, of the parents, guardian or other person having charge or control of a child placed in the program.

3. An interagency agreement for cooperation executed by the local departments of health and social services or welfare; the juvenile and domestic relations district court; law-enforcement agencies; institutions of higher education and other postsecondary training programs; professional and community organizations; the business and religious communities; dropout prevention and substance abuse prevention programs; community services boards located in the applicants' respective jurisdictions; and the Department of Correctional Education.

4. A curriculum developed for intensive, accelerated instruction designed to establish high standards and academic achievement for participating students.

5. An emphasis on building self-esteem and the promotion of personal and social responsibility.

6. A low pupil teacher ratio to promote a high level of interaction between the students and the teacher.

7. An extended day program, where appropriate, to facilitate remediation; tutoring; counseling; organized, age-appropriate, developmental education for elementary and middle school children; and opportunities that enhance acculturation and permit students to improve their social and interpersonal relationship skills.

8. Community outreach to build strong school, business, and community partnerships, and to promote parental involvement in the educational process of participating children.

9. Specific, measurable goals and objectives and an evaluation component to determine the program's effectiveness in reducing acts of crime and violence by students, the dropout rate, the number of youth committed to juvenile correctional centers, and recidivism; and in increasing the academic achievement levels and rehabilitative success of participating students, admission to institutions of higher education and other postsecondary education and training programs, and improving staff retention rates.

10. The number of children who may be assigned to the regional pilot alternative education program during the school year.

11. A plan for transitioning the enrolled students into the relevant school division's regular program.

12. A current program of staff development and training.

C. Beginning with the first year of program implementation, the Department of Education shall be entitled to deduct annually from the locality's share for the education of its students a sum equal to the actual local expenditure per pupil for the support of those students placed by the relevant school division in any such pilot program. The amount of the actual transfers shall be based on data accumulated during the prior school year.

D. A school board shall require written notification to the pupil's parent, guardian, or other person having charge or control, when a pupil commits an offense in violation of school board policies, which school officials determine was committed without the willful intent to violate such policies, or when the offense did not endanger the health and safety of the individual or other persons, of the nature of the offense no later than two school days following its occurrence. A school board shall require the principal of the school where the child is in attendance or other appropriate school personnel to develop appropriate measures, in conjunction with the pupil's parent or guardian, for correcting such behavior.

E. The Board shall require submission of interim evaluation reports of each pilot program biannually and shall compile these reports and other program materials and report the status of such programs on a periodic basis, as may be established, during the 1993 legislative interim to the Special Joint Subcommittee on School Crime and Violence. The Board shall report the effectiveness of such programs and their components annually to the Governor and the General Assembly beginning by December 1, 1994.

F. For the purposes of this section, "regional pilot program" means a program supported and implemented by two or more school divisions which are either geographically contiguous or have a community of interest.

G. For the purposes of this section, "one school year" means no more than 180 teaching days.

(1993, cc. 819, 856; 1994, c. 762; 1995, c. 533; 1996, cc. 755, 914; 2000, c. 739; 2004, cc. 939, 955.)

Board of Education Agenda Item

Item: L **Date:** October 22, 2009

Topic: First Review of *Educational Technology Plan for Virginia: 2009-15*

Presenter: Lan Neugent, Assistant Superintendent for Technology & Career Education

Telephone Number: 804-225-2757 **E-Mail Address:** lan.neugent@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_x_ Board review required by
- _x_ State or federal law or regulation
- ____ Board of Education regulation
- ____ Other: _____

_x_ Action requested at this meeting _x_ Action requested at future meeting: 11/17/09 (date)

Previous Review/Action:

_x_ No previous board review/action

____ Previous review/action
date _____
action _____

Background Information:

Code of Virginia § 22.1-253.13:6. Standard 6. Planning and public involvement.

> A. The Board of Education shall adopt a statewide comprehensive, unified, long-range plan based on data collection, analysis, and evaluation. Such plan shall be developed with statewide participation. The Board shall review the plan biennially and adopt any necessary revisions. The Board shall post the plan on the Department of Education's website if practicable, and, in any case, shall make a hard copy of such plan available for public inspection and copying.
>
> This plan shall include the objectives of public education in Virginia, including strategies for first improving student achievement, particularly the achievement of educationally at-risk students, then maintaining high levels of student achievement; an assessment of the extent to which these objectives are being achieved; a forecast of enrollment changes; and an assessment of the needs of public education in the Commonwealth. In the annual report required by § 22.1-18, the Board shall include an analysis of the extent to which these Standards of Quality have been achieved and the objectives of the statewide comprehensive plan have been met. The Board shall also develop, consistent with, or as a part of, its comprehensive plan, a detailed comprehensive, long-range plan to integrate educational technology into the Standards of Learning and the curricula of the public schools in Virginia, including career and technical

education programs. The Board shall review and approve the comprehensive plan for educational technology and may require the revision of such plan as it deems necessary.

The *Educational Technology Plan for Virginia: 2009-15* builds on the work of previous six-year technology plans, especially in the areas of technology infrastructure, integration, and evaluation. It reflects current state and national standards relating to student, teacher, and administrator technology skills. It also incorporates recent research into the skills needed by 21st century citizens, the way the brain acquires knowledge, and capabilities of current and future technologies. Because the world in which we use technology is changing just as rapidly as technology, the basis of the new technology plan is a framework for how technology can most effectively be used. Technologies may evolve in many ways, but the characteristics of educationally-potent technology are well-established. The conceptual framework also encourages divisions to view educational technology in the context of all the myriad functions of an educational system. The flexibility of the framework allows divisions to leverage their unique strengths and minimize their local gaps between promise and practice.

Summary of Major Elements:
The introduction to the *Educational Technology Plan for Virginia: 2009-15* provides a concise overview of the current educational environment, both for the state and the nation. The conceptual framework for this plan is briefly introduced and illustrated with an example of one educational technology project. Goals and objectives for the six-year technology plan are provided in outline form with particular strategies for implementation as well as evaluation. Recent research applicable to each of the five focus areas of the conceptual framework is summarized, and the various characteristics of the focus areas are more fully explained. Three appendices provide further detail*: Essential Elements of ICT (Information and Communications Technology) Literacy*, *Status of Technology Use in Virginia*, and *Division Plan Alignment: 2009-15.*

An executive summary is provided in a separate document.

Superintendent's Recommendation:
The Superintendent of Public Instruction recommends that the Board of Education accept for first review the proposed *Educational Technology Plan for Virginia: 2009-15.*

Impact on Resources:
The *Educational Technology Plan for Virginia: 2009-15* will be implemented using existing fiscal and administrative resources.

Timetable for Further Review/Action:
The proposed revisions to the plan will be posted on the Department's Web site for 20 days to provide school divisions and other interested parties with the opportunity to review them and offer comments. The comments will be compiled and presented to the Board at its meeting on November 17, 2009, and will be considered in the final version of the plan presented to the Board. It is anticipated that the final plan will be presented to the Board at its November 17, 2009, meeting with a request for final approval.

EXECUTIVE SUMMARY

DRAFT

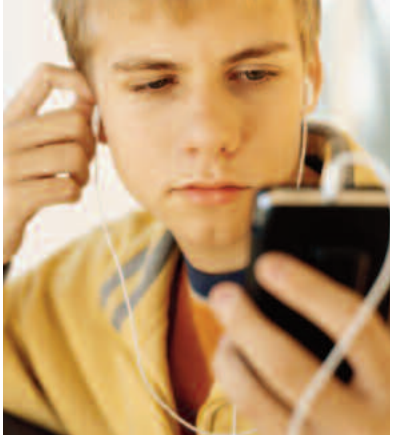
2009-15

Educational Technology Plan for Virginia

2009-15

Educational Technology Plan for Virginia

EXECUTIVE SUMMARY



2009-15

Preface

The *Educational Technology Plan for Virginia: 2003-09* opened with the following statement:

Virginia's leaders have prepared the commonwealth to be attractive to companies and investors by providing the technology infrastructure and skilled workforce today's businesses require. Critical to the commonwealth's ability to capitalize on this advantage is the extent to which Virginia's schools prepare the next-generation workforce for knowledge-based jobs that utilize cutting-edge information technology.

These sentiments are remarkably insightful for not only 2003 and 2009 but likely 2015 and beyond. Virginia remains ahead of the curve nationally in its commitment to educational technology and focus on preparing students for the changing economy and information age.

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Perhaps the greatest change during the last six years is that students of all ages have transitioned from being just *consumers* of content and media to also being *producers*. Educational technology is no longer a one-way learning resource. The Internet is much more than a high-tech encyclopedia; it is a virtual world, with all the pros and cons of the real world. To oversimplify the daunting goal of the next six years, educators must find ways to maximize the positives of the Internet and other technologies while preparing students and their families for the potential negatives. This is an ambitious goal, especially when set against the demands of meeting state and federal standards.

The realities of the world and economy further complicate the immense challenges of planning the future of educational technology. For decades, U.S. schools emphasized mathematics and science in direct response to the Soviet Union's launch of *Sputnik 1* in 1957 and the belief that the Cold War would be won through superior technological knowledge. While mathematics and science are as important now as they were a half-century ago, the challenges of the 21st century have supplanted the threats of the Cold War as the driving force behind American education.

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As a result of the continually changing nature of educational technology, state and federal standards, and the world's economy, this six-year plan is not a *plan* in the traditional sense; rather, it is a framework that permits ongoing changes, innovations, and emerging technologies. It allows educators and students to think differently about how technology can change teaching and learning. Education in the 21st century is a complex system, and we must consider it from this perspective. By their nature, children are naturally creative and curious; however, self-expression does not come easily for some children. Over the next six years, countless emerging technologies could help all students better communicate their questions, knowledge, skills, and thoughts, which can only help them learn more. The challenge for educators is to help students identify and use tools to express themselves more effectively and creatively and accomplish work that would be difficult, or even impossible, to do without technology.

To meet this challenge, most educators will need to approach technology from a radically different perspective. They increasingly will spend more time modeling creative thinking and showing how to probe information rather than teaching facts. In many instances, they will find themselves serving more as facilitators of information gathering and analysis than as the conduits.

This evolution does not portend the end of teaching; to the contrary, educators will play a larger role than ever before. The availability of the Internet and other instant-technology-information sources will free up time, which can be dedicated to teaching critical-thinking skills, encouraging creativity, and relating learning directly to real-world situations that are meaningful to students. As a result, this plan takes a systemic approach, focusing on the roles of technology in the entire education process.

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21st Century Skills

In 1983, the U.S. Department of Education alerted Americans that failures in the education system could hinder economic development and the country's role as a global leader (USDOE, 1983). A quarter-century later, the U.S. Department of Education revisited this assessment and warned Americans once again:

> If we were "at risk" in 1983, we are at even greater risk now. The rising demands of our global economy, together with demographic shifts, require that we educate more students to higher levels than ever before. Yet, our education system is not keeping pace with these growing demands (USDOE, 2008a, bullet 1).

Increasingly, employers look for skills beyond academic knowledge (U.S. Department of Labor, 2000). A decade ago, these nebulous aptitudes were labeled under the extremely broad term *21st century skills*. As the new century has unfolded, various studies have postulated about the likely competencies that will be needed in the workplace of tomorrow; one consistent conclusion is that technology will be integrated into every facet of business and life. The research also indicates that for students to compete in the global economy and be responsible citizens, education clearly must focus on 21st century skills (Metiri Group, 2003; Conference Board, Corporate Voices for Working Families, Partnership for 21st Century Skills, & Society for Human Resource Management, 2006; CEO Forum, 2001; Partnership for 21st Century Skills, 2007).

The *Educational Technology Plan for Virginia: 2009-15* focuses primarily on one specific component of 21st century skills: information and communications technology (ICT) literacy. The most recognized definition for this topic was formulated by the International ICT Literacy Panel (2002): "ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (p. 2). The State Educational Technology Directors Association (SETDA) (2002) further explained: "Technology literacy is

the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century" (n.p.).

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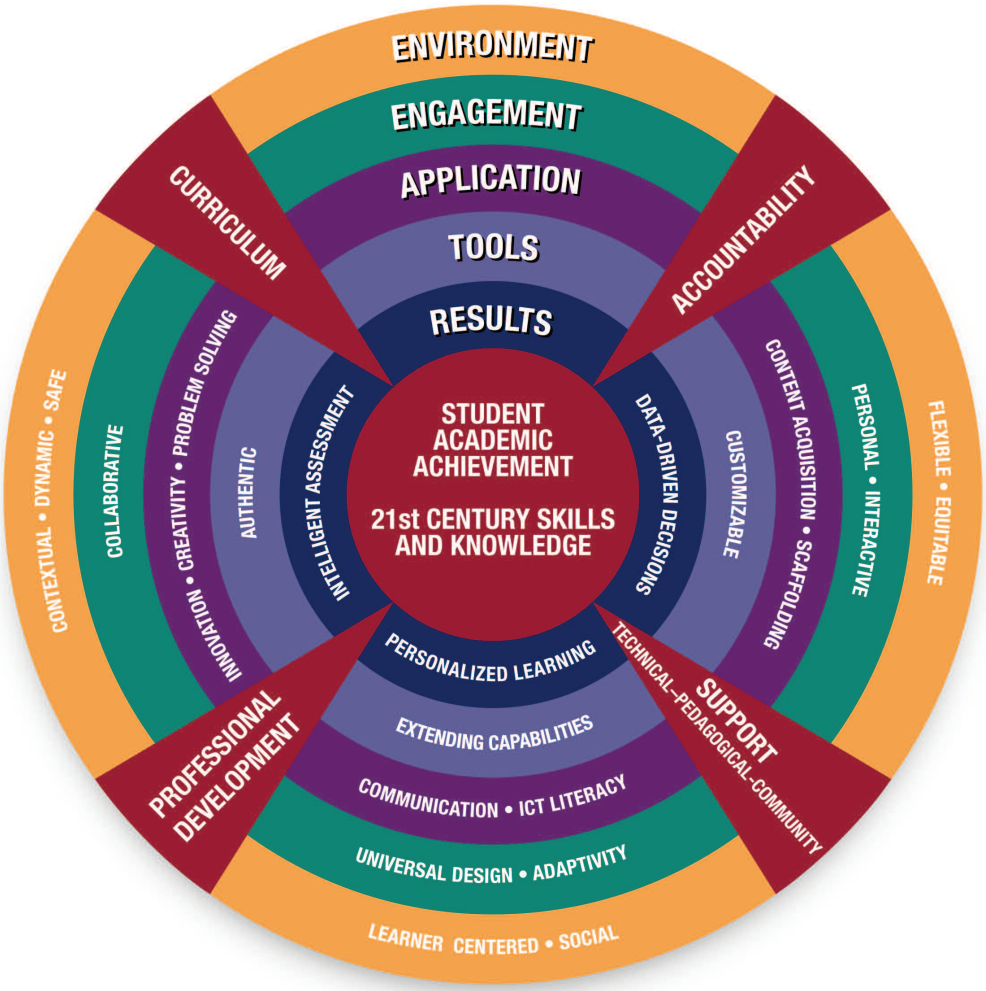
Conceptual Framework

The *Educational Technology Plan for Virginia: 2009-15* builds upon the foundation established by the *Educational Technology Plan for Virginia: 2003-09*, Computer/Technology Standards of Learning, Technology Standards for Instructional Personnel, NETS*S, NETS*T, NETS*A, and the goals for ICT literacy. To foster the development of 21st century skills, the plan relies extensively on factors that support effective technology use:

1. Appropriately and adequately designed environment
2. Meaningful engagement
3. Purposeful application of tools for learning
4. Use of authentic technology tools to extend learning capabilities
5. Authentic and intelligent assessments

Conceptual Framework

Educational Technology Plan for Virginia: 2009-15



The conceptual framework shows five focus areas for educational technology in Virginia between 2009 and 2015:

- Schools need to consider physical and virtual **environments** in new and innovative ways to support learning activities.

- Educators must employ multiple ways to engage students in learning through technology. This **engagement** should reflect student learning styles, cultural backgrounds, and personal interests.

- Students need to understand the proper **application** of technology tools (i.e., choosing and applying the most appropriate technology for communicating and problem solving) and to be creative and innovative.

- Students should not use technology **tools** just to replicate paper-and-pencil activities. Tools should extend student capabilities to perform functions that would be difficult, if not impossible, without technology. Tools should be authentic—ones students will encounter in the nonschool environment.

- **Results** are not just a matter of meeting accountability requirements but using data, including real-time assessments, to inform instruction. Teachers addressing 21st century skills and knowledge must employ intelligent assessments.

These five focus areas underlie the plan's goals. Each focus area comprises a number of topics that form the basis for the plan's objectives. Four key educational components cut across these focus areas:

- Accountability

- Support

- Professional development

- Curriculum

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Goals and Objectives

The *Educational Technology Plan for Virginia: 2009-15* imparts state-level goals and objectives grounded in a foundation of research and based on identified needs. School divisions must develop locally appropriate strategies and measures that address these statewide goals and objectives while, at the same time, leveraging their unique strengths and minimizing the gaps between promise and practice. Beyond the goals and objectives of the state's plan, division technology committees may create effective plans by adding goals and objectives that support division missions and visions.

Virginia school divisions are practiced in the art and science of good planning procedures. Division technology plans need to follow these procedures, reflect state and local goals, and be useful to all stakeholders. With an increased emphasis on supportive data collection, divisions also must collect appropriate and useful information during the evaluation phase of the planning cycle.

The Virginia Department of Education has generated some tools to help divisions formulate their technology plans. An alignment document focuses on both the planning process and the plan itself. Additionally, the Department has developed an outline of the educational technology data that must be collected.

Goal 1: Provide a safe, flexible, and effective learning environment for all students

Objective 1.1: Deliver appropriate and challenging curricula through face-to-face, blended, and virtual learning environments.

Objective 1.2: Provide the technical and human infrastructure necessary to support real, blended, and virtual learning environments.

Objective 1.3: Provide high-quality professional development to help educators create, maintain, and work in a variety of learner-centered environments.

Goal 2: Engage students in meaningful curricular content through the purposeful and effective use of technology.

Objective 2.1: Support innovative professional development practices that promote strategic growth for all educators and collaboration with other educators, content experts, and students.

Objective 2.2: Actualize the ability of technology to individualize learning and provide equitable opportunities for all learners.

Objective 2.3: Facilitate the implementation of high-quality Internet safety programs in schools.

Goal 3: Afford students with opportunities to apply technology effectively to gain knowledge, develop skills, and create and distribute artifacts that reflect their understandings.

Objective 3.1: Provide and support professional development that increases the capacity of teachers to design and facilitate meaningful learning experiences, thereby encouraging students to create, problem-solve, communicate, collaborate, and use real-world skills by applying technology purposefully.

Objective 3.2: Ensure that students, teachers, and administrators are ICT literate.

Objective 3.3: Implement technology-based formative assessments that produce further growth in content knowledge and skills development.

Goal 4: Provide students with access to authentic and appropriate tools to gain knowledge, develop skills, extend capabilities, and create and disseminate artifacts that demonstrate their understandings.

Objective 4.1: Provide resources and support to ensure that every student has access to a personal computing device.

Objective 4.2: Provide technical and pedagogical support to ensure that students, teachers, and administrators can effectively access and use technology tools.

Objective 4.3: Identify and disseminate information and resources that assist educators in selecting authentic and appropriate tools for all grade levels and curricular areas.

Goal 5: Use technology to support a culture of data-driven decision making that relies upon data to evaluate and improve teaching and learning.

Objective 5.1: Use data to inform and adjust technical, pedagogical, and financial support.

Objective 5.2: Provide support to help teachers disaggregate, interpret, and use data to plan, improve, and differentiate instruction.

Objective 5.3: Promote the use of technology to inform the design and implementation of next-generation standardized assessments.

The goals, objectives, and methods of this plan incorporate the best thinking about ICT literacy and cognitive science. The overarching goal is to craft a flexible framework that allows individual schools and divisions to implement systemic changes that support 21st century learning and greater academic achievement. Just as this plan builds upon national standards, division plans should not only align with the statewide framework but also define specific objectives based upon local-needs assessments. The bottom line is that technology should be an essential means for supporting 21st century learning and academic achievement; it is not, however, an end unto itself.

While technology can generate new and innovative opportunities, the more important consideration is its value and applicability to meeting each school's goals and objectives. This occurs through understanding these goals and objectives, learning about the capabilities of the technology, and carefully planning for technology use and application in the educational environment. By understanding these factors thoroughly, schools will use time and resources efficiently and effectively while creating opportunities for student academic success.

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2009-15

Educational Technology Plan for Virginia

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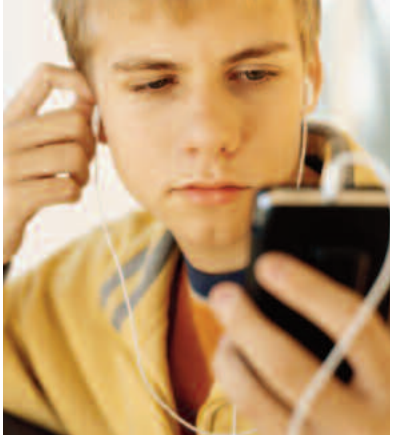

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Vision

The vision of the Virginia Board of Education and Virginia Department of Education, in cooperation with their partners, is to create an excellent statewide system of public education that derives strength from its diversity and that ensures equality of opportunity for each student in a safe and healthy learning environment. The goal of this system is to prepare all students to be capable, responsible, and self-reliant citizens in the global society. To that end, the Department of Education will integrate innovative and authentic technologies effectively throughout all facets of the educational system to improve student academic achievement and 21st century skills and knowledge.

Mission

The Virginia Department of Education's Division of Technology and Career Education supports school division educational improvement efforts through the use of technology. The division provides training, technical assistance, and information to agency personnel and school divisions. The 2009-15 plan outlines strategic direction for agency and local educational technology planning while providing the flexibility to accommodate ongoing changes, innovations, and emerging technologies.

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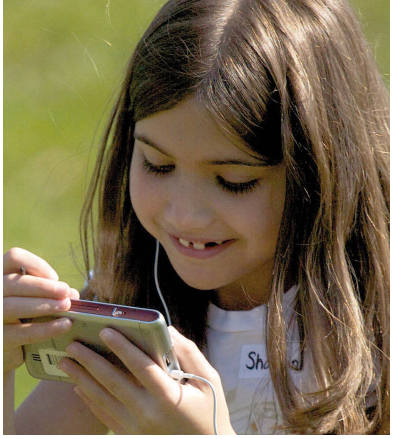
Acknowledgments

The development of the *Educational Technology Plan for Virginia: 2009-15* was coordinated by the Office of Educational Technology and represents more than a year of research, planning, and collaboration. Contributors to the plan include individuals and organizations from across the Commonwealth, representing school division technology directors, administrators, teachers, higher education representatives, professional organizations, the business community, and families. The level of participation precludes us from identifying each contributor by name; however, we want to extend our sincere appreciation to all those who helped shape this vision for educational technology in Virginia.



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Foreword

Virginia is consistently recognized as a national leader in the use of technology to expand student opportunities. In the most recent *Technology Counts* report, *Education Week* gave Virginia an overall grade of A-. Indeed, with the foresight and commitment of legislators, governors, and educators, the Commonwealth has an impressive list of accomplishments over the last decade.

In 2000, Virginia implemented the Web-Based Standards of Learning initiative—providing the infrastructure and hardware for instructional, remedial, and testing programs. The testing program has expanded with 1.7 million tests completed online in 2009.

In 2004, the Virginia Educational Information Management System began providing data disaggregation capabilities to help school divisions track student achievement longitudinally. This system provides instant access to data that shape instruction to meet the individual needs of Virginia's students.

In 2004, Virtual Virginia was launched to provide Advanced Placement (AP) and other challenging courses for more than 2,500 middle and high school students from 238 middle and high schools across the Commonwealth. In addition, approximately 5,700 students receive tailored remedial instruction through the Virginia Online Reading Tutorial and the Virginia Online Algebra Tutorial.

In 2005, Virginia created a network of more than 1,200 instructional technology resource teachers (ITRT) to help teachers integrate technology into the classroom effectively. With this action, Virginia became the first state in the nation to provide instructional technology support to teachers on this scale. At the same time, the Commonwealth added technology support personnel to ensure the effective operation and maintenance of the technology and supporting infrastructure.

In 2006, Virginia became the first state to require that Internet safety be taught as part of the instructional program, preparing students to experience all the offerings of the Internet and Web 2.0 technologies safely and fully.

In 2007, Virginia launched *Share the Skies*, which allows students and teachers to study astronomy in real time during the daytime without leaving the classroom. Virginia students can use research-grade telescopes to explore Australia's night skies via the Internet.

Since 2008, the *Learning without Boundaries* initiative has helped the Commonwealth understand the technical, social, and policy implications of integrating wireless handheld devices into schools.

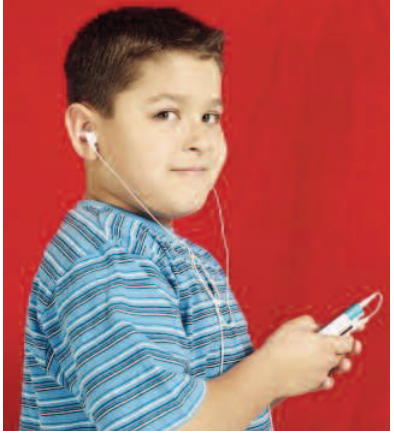
In 2009, the Commonwealth focused on innovative ways to provide high-quality content and instructional materials for students. Virginia on iTunes U provides a Web-based repository for standards-based media-rich content for schools and families. A physics *flexbook* also was created in 2009 to supplement traditional physics textbooks with emerging topics.

The Department of Education will continue exploring and implementing innovative ways to improve teaching, learning, and productivity in schools. The *Educational Technology Plan for Virginia: 2009-15* articulates our vision and provides a framework to support this work.

Patricia I. Wright, Ed.D.
Superintendent of Public Instruction

"Without continual growth and progress, such words as improvement, achievement, and success have no meaning."

—Benjamin Franklin



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Preface

The *Educational Technology Plan for Virginia: 2003-09* opened with the following statement:

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As a result of the continually changing nature of educational technology, state and federal standards, and the world's economy, this six-year plan is not a *plan* in the traditional sense; rather, it is a framework that permits ongoing changes, innovations, and emerging technologies. It allows educators and students to think differently about how technology can change teaching and learning.

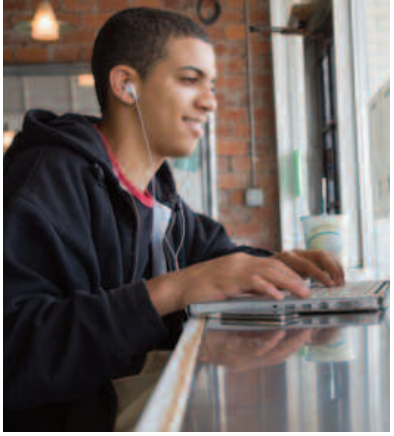
Education in the 21st century is a complex system, and we must consider it from this perspective. By their nature, children are naturally creative and curious; however, self-expression does not come easily for some children. Over the next six years, countless emerging technologies could help all students better communicate their questions, knowledge, skills, and thoughts, which can only help them learn more. The challenge for educators is to help students identify and use tools to express themselves more effectively and creatively and accomplish work that would be difficult, or even impossible, to do without technology.

To meet this challenge, most educators will need to approach technology from a radically different perspective. They increasingly will spend more time modeling creative thinking and showing how to probe information rather than teaching facts. In many instances, they will find themselves serving more as facilitators of information gathering and analysis than as the conduits.

This evolution does not portend the end of teaching; to the contrary, educators will play a larger role than ever before. The availability of the Internet and other instant-technology-information sources will free up time, which can be dedicated to teaching critical-thinking skills, encouraging creativity, and relating learning directly to real-world situations that are meaningful to students. As a result, this plan takes a systemic approach, focusing on the roles of technology in the entire education process.

"Arriving at one goal is the starting point of another."

—John Dewey



2009-15

Introduction

In 1983, the U.S. Department of Education published *A Nation At Risk* (USDOE, 1983), which alerted Americans that failures in the American education system could hinder economic development and the country's role as a global leader. The department reported, "The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people" (paragraph 1). A quarter-century later, the U.S. Department of Education revisited this report in *A Nation Accountable* (USDOE, 2008a), which warned Americans once again:

> If we were "at risk" in 1983, we are at even greater risk now. The rising demands of our global economy, together with demographic shifts, require that we educate more students to higher levels than ever before. Yet, our education system is not keeping pace with these growing demands (bullet 1).

The U.S. Department of Labor (2000) voiced its concerns about the country's educational focus in the report *A Nation of Opportunity: Building America's 21st Century Workforce,* which noted that employers increasingly look for skills beyond academic knowledge. This emphasis on nonacademic skills has inspired other organizations to define *21st century skills* more precisely. In 2001, the CEO Forum, a temporary working group of technology industry and education leaders, published *School Technology and Readiness Report, Year 4: Key Building Blocks for Student Achievement in the 21st Century*. Two of the forum's six recommendations focused on 21st century skills: (1) making the development of 21st century skills a key educational goal and (2) aligning student assessment with educational objectives, including 21st century skills. The report affirmed that technology integration could help foster these 21st century skills.

The 21st century skills adopted by the CEO Forum actually were articulated by the Metiri Group (2003), in a work commissioned by the North Central Regional Educational Laboratory (NCREL). This publication categorized the skills needed for the 21st century under these topics: digital age literacy, inventive thinking, effective communication, and high productivity.

In response, government, education, and business leaders formed Partnership for 21st Century Skills, which published two seminal reports: *Learning for the 21st Century* (2003) and *Framework for 21st Century Learning* (2007, rev. ed.). This latter work outlined student outcomes and support systems essential for 21st century skills. Outcomes were grounded in core subjects and 21st century themes, including skills related to life and career, learning and innovation, and media and technology. Support systems included standards and assessments, curriculum and instruction, professional development, and learning environments. It has become apparent that education must focus on these subjects to help students compete in the global economy and be responsible citizens (Conference Board, Corporate Voices for Working Families, Partnership for 21st Century Skills, & Society for Human Resource Management, 2006; CEO Forum, 2001; Partnership for 21st Century Skills, 2007).

The *Educational Technology Plan for Virginia: 2009-15* focuses primarily on one specific component of 21st century skills: information and communications technology (ICT) literacy. The most recognized definition for this topic was formulated by the International ICT Literacy Panel (2002): "ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (p. 2). The State Educational Technology Directors Association (SETDA) (2002) further explained: "Technology literacy is the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century" (n.p.).

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Computer and Technology Standards

Technology will play a key role in the teaching and development of 21st century skills and knowledge. The International Society for Technology in Education (ISTE) released the initial National Educational Technology Standards for Students (NETS*S) in 1998. In response, the Commonwealth of Virginia incorporated these standards into the Standards of Learning (SOL) and revised the computer technology SOL in 2005 to reflect 21st century skills.

In 2007, ISTE updated the NETS*S to recognize the importance of the following 21st century factors:

- **Creativity and innovation**
- **Communication and collaboration**
- **Research and information fluency**
- **Critical thinking, problem solving, and decision making**
- **Digital citizenship**
- **Technology operations and concepts**

While some of these skills may be taught without technology, others are dependent on technology. Even the skills not dependent on technology are strengthened and enhanced when appropriate technology is used effectively and modeled on research-based best practices.

Core-content knowledge is necessary, but not solely sufficient, to succeed in a competitive world. Even if all students mastered core academic subjects, they still would be woefully underprepared to succeed in postsecondary institutions and workplaces, which increasingly value people who use knowledge to communicate, collaborate, analyze, create, innovate, and problem-solve. Used comprehensively, technology helps students develop 21st century skills (Partnership for 21st Century Skills,

2007). Research (Dede, 2007) and practical experience show that students develop 21st century skills most effectively when teachers combine situated learning and effective ICT literacy.

In 2008, ISTE updated the National Educational Technology Standards and Performance Indicators for Teachers (NETS*T) based on the philosophy that teachers should model effective technology use. The NETS*T require teachers to meet specific standards and performance indicators:

- **Facilitate and inspire student learning and creativity**
- **Design and develop digital-age learning experiences and assessments**
- **Model digital-age work and learning**
- **Promote and model digital citizenship and responsibility**
- **Engage in professional growth and leadership**

The ISTE National Educational Technology Standards for Administrators (NETS*A) were updated and released in June 2009. These new standards also incorporate more aspects of 21st century learning and teaching, just as the refreshed NETS*S and NETS*T have done. They still focus, however, on the leadership and oversight roles of administrators, though an emphasis on systemic transformation through technology expands the administrative vision. Specifically, the NETS*A articulate standards and performance indicators around the following:

- **Visionary leadership**
- **Digital-age learning culture**
- **Excellence in professional practice**
- **Systemic improvement**
- **Digital citizenship**

Virginia's Definition of ICT Literacy

The Commonwealth of Virginia has taken a significant step forward by articulating essential ICT literacy elements for all stakeholders (see Appendix A). Based in part on SETDA's definition, Virginia defines ICT literacy as a synergistic blend of cognitive, technical, and social skills that enable students to

use technology responsibly (safely and ethically) and effectively to advance learning and develop strong thinking habits in all subject areas. This blend should lead each student toward a lifelong ability to communicate; solve problems; and access, manage, integrate, evaluate, and create information.

Instructional Technology Resource Teachers (ITRT)

In 2005, the Virginia General Assembly began requiring divisions to employ one ITRT per 1,000 students to help integrate technology into classrooms. A study by Virginia Tech's Center for Assessment, Evaluation, and Educational Programming determined that ITRT have become an essential part of educational technology in the Commonwealth (Virginia Department of Education, 2007).

The research found that ITRT are "overwhelmingly qualified for their positions, work consistently on appropriate tasks, and train teachers regularly in the latest technologies. While some teachers still resist incorporating technology, the program has helped many overcome their fears; an increasing number have taken advantage of the ITRT program, particularly through technology integration, software training, and the development of curriculum resources" (p. 2).

The study added that ITRT have contributed to major improvements in 32 percent of the SOL test areas, with the most significant impact occurring in English reading; however, improvements also were observed in eighth-grade English writing and fifth-grade mathematics. The study recommended that the program would achieve even greater success by hiring at least one ITRT per school, clarifying their duties more precisely, and encouraging administrators to work more closely with them (Virginia Department of Education, 2007).

Technology Support Positions

In 2005, the Virginia General Assembly also began requiring divisions to employ a second technology position aimed at providing technology support for schools. School divisions must employ one technology support position per 1,000 students. This position provides support for information networks; software and hardware installation, maintenance, and repair; security management; and other related responsibilities. In the most recent educational technology survey, 93 percent of respondents believe their school's technology is reliable, and 92 percent believe technical support for teachers is adequate (Virginia Department of Education, 2009).

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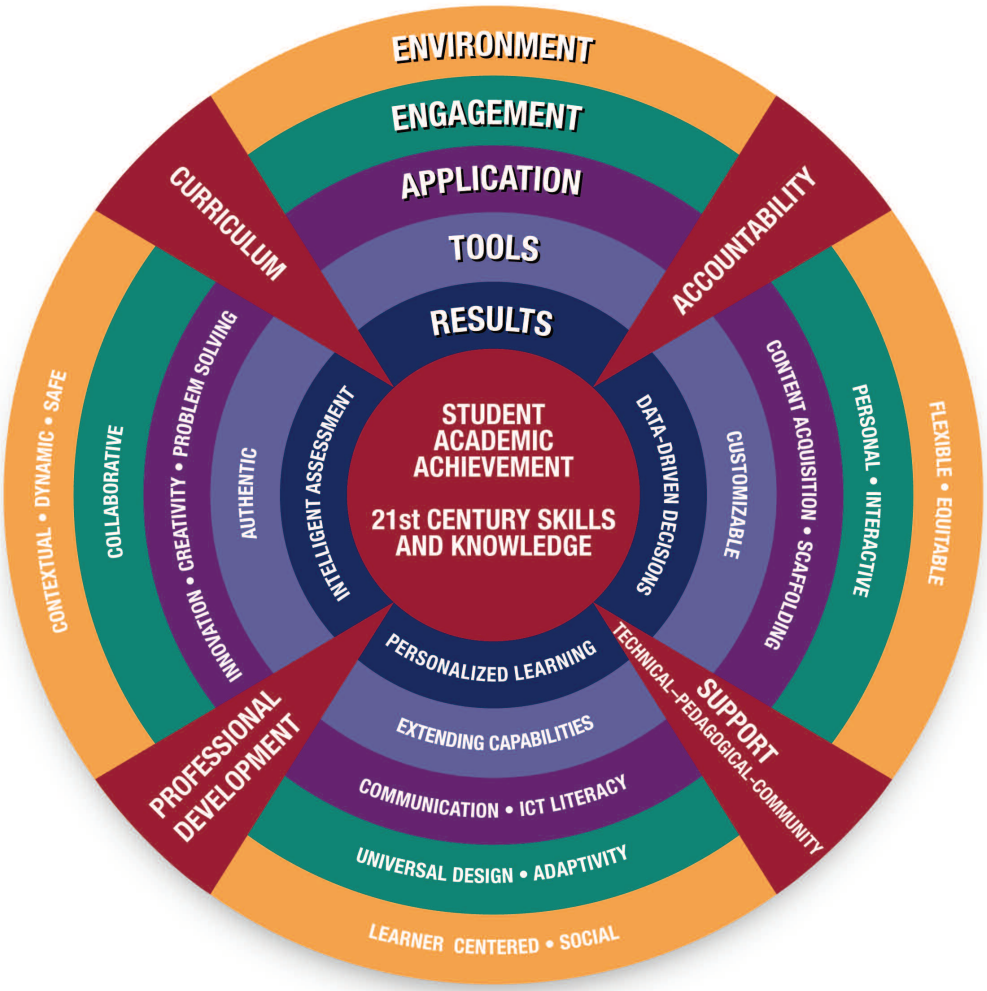
Conceptual Framework

The *Educational Technology Plan for Virginia: 2009-15* builds upon the foundation established by the *Educational Technology Plan for Virginia: 2003-09*, Computer/Technology Standards of Learning, Technology Standards for Instructional Personnel, NETS*S, NETS*T, NETS*A, and the goals for ICT literacy. To foster the development of 21st century skills, the plan relies extensively on factors that support effective technology use:

- **Appropriately and adequately designed environment**
- **Meaningful engagement**
- **Purposeful application of tools for learning**
- **Use of authentic technology tools to extend learning capabilities**
- **Authentic and intelligent assessments**

Conceptual Framework

Educational Technology Plan for Virginia: 2009-15



The conceptual framework shows five focus areas for educational technology in Virginia between 2009 and 2015:

- Schools need to consider physical and virtual **environments** in new and innovative ways to support learning activities.

- Educators must employ multiple ways to engage students in learning through technology. This **engagement** should reflect student learning styles, cultural backgrounds, and personal interests.

- Students need to understand the proper **application** of technology tools (i.e., choosing and applying the most appropriate technology for communicating and problem solving) and to be creative and innovative.

- Students should not use technology **tools** just to replicate paper-and-pencil activities. Tools should extend student capabilities to perform functions that would be difficult, if not impossible, without technology. Tools should be authentic—ones students will encounter in the nonschool environment.

- **Results** are not just a matter of meeting accountability requirements but using data, including real-time assessments, to inform instruction. Teachers addressing 21st century skills and knowledge must employ intelligent assessments.

These five focus areas underlie the plan's goals. Each focus area comprises a number of topics that form the basis for the plan's objectives. Four key educational components cut across these focus areas:

- **Accountability**
- **Support**
- **Professional development**
- **Curriculum**

The goals, objectives, and methods of this plan incorporate the best thinking about ICT literacy and cognitive science. The overarching goal is to craft a flexible framework that allows individual schools and divisions to implement systemic changes that support 21st century learning and greater academic achievement. Just as this plan builds upon national standards, division plans should not only align with the statewide framework but also define specific objectives based upon local-needs assessments. The bottom line is that technology should be an essential means for supporting 21st century learning and academic achievement; it is not, however, an end unto itself.

These four areas are common to education and familiar to educators and those who work with them. Instead of adding another definition of these factors to what we already know, the following example illustrates how one innovative project embodies all of these factors.

Sharing the Skies: Boundless Possibilities

The Conceptual Framework in Practice

In 2007, the Virginia Department of Education Office of Educational Technology developed an innovative project that encompasses all aspects of the conceptual framework. *Share the Skies* is the nation's first statewide initiative that enables students and teachers to

study astronomy in real time during the daytime without leaving the classroom. Virginia students can access and control a research-grade telescope to explore Australia's night skies via the Internet. They use CCD (charge-coupled device) imaging techniques to capture digital images of deep space for further study.

Environment

Share the Skies epitomizes the concept of a rich and multidimensional environment. From their classroom environments, students use a Web browser to control a telescope in Australia and explore deep space. This technology expands classroom walls to a learning environment millions of light years away.

The environment allows students to leverage this tool to explore subjects across the **curriculum**. In addition to the obvious implications for science and mathematics instruction, it also taps into language arts, history, and visual arts by helping learners understand the impact of astronomy on thousands of years of religious customs and cultural beliefs.

Share the Skies provides **accountability** across system and classroom levels. When working in a distributed environment, accountability is essential. The tools must function properly, teachers must provide proper guidance, and students must use the tools correctly. Educators must assess students' roles in terms of their work with the telescope and collaboration with learners in other locations. It is incumbent upon teachers to ascertain each student's individual achievement in an environment where thousands of students are participating.

Technical **support** must be coordinated on many levels and in several locations. Telestra, an Australian telecommunications company, assures the network is operational; Software Bisque of Golden, Colorado, developed and maintains the software; and New Mexico Skies Observatory maintains the remote access and provides operational support. At the Virginia school level, teachers rely on the expertise of ITRT, who have been trained to work with *Share the Skies*. Teachers and ITRT also receive technical and pedagogical support from the Virginia Department of Education.

Professional development is essential for teachers not only to learn details about the project but also to understand how to work in a distributed environment. Since the project involves various places spanning the Earth and multiple time zones, teachers must anticipate potential issues. For instance, learners need to calculate when to schedule telescope usage based on the time of day and year, i.e., during Daylight Savings Time, there is a 12-hour gap between Virginia and Australia.

Engagement

The project offers learners flexibility in what and how students learn. *Share the Skies* incorporates a Web 2.0 platform provided by Oracle Education Foundation. It allows learners to develop collaborative research projects, and the complexity can be scaled to a learner's age level and abilities. Aiming the telescope and taking a photo also steps learners through a series of problem-solving tasks, which range

from setting the exposure time to checking the weather; as a result, they develop deeper insight into the entire process. While students can access deep space images on the Web, it does not compare to the level of engagement young learners experience as they take the telescope and camera virtually into their own hands.

The associated **curriculum** helps engage students by expanding their comprehension of deep space and challenging them to achieve at a higher level. While the complexity can be scaled to different age levels, some younger students may be capable of more advanced studies. They are learning science by *doing* real science and must draw on knowledge and skills across the curriculum to solve these authentic research problems. The practical uses of mathematics, for example, become apparent as conceptual learning, rather than rote operations, is emphasized.

In a project that engages students in multiple ways, **accountability** assumes numerous forms. The project's varied opportunities must be assessed continually: Are the learners' individual needs being met? Do they have choices in their learning? Do their experiences reflect their personal experiences, backgrounds, and cultural beliefs? Educators are accountable for assessing what students bring to their learning as much as what they learn.

Students should understand the potentials and limitations of the telescope. For instance, technical **support** can engage students by guiding them toward specific objects that can be imaged while allowing them the flexibility to pursue other possibilities.

Working with students from around the world heightens awareness of cultural differences. **Professional development** can help teachers better appreciate how to design projects that engage students from a variety of backgrounds and experiences in authentic, collaborative research.

Application

The key to selecting the right tool is to understand how it will be used. In this instance, the Virginia telescope is optimal for deep space but not planets, which are typically too bright to image successfully. Early in the project, students learn that different telescopes are necessary for different applications. They compare their optical telescope to other telescopes, such as the massive radio telescope at Green Bank, West Virginia. This demonstrates that they must first determine what they need to accomplish and how a tool should be applied before choosing the tool.

The **curriculum** supports problem solving and knowledge acquisition across disciplines. It allows educators to help improve presentation, communication, writing, and computer skills—all in one assignment. It also encourages learners to formulate and execute inquiry-based projects in a creative manner.

While the telescope and Web browser are simple to use on a basic level, they must be applied in ways that support **accountability** and age-appropriate goals and objectives. This project is flexible enough to support the Standards of Learning (SOL) and challenge advanced learners with opportunities beyond their grade levels. Educators must understand their students' abilities and the project's capabilities. After all, with a research-grade telescope, the potential exists for even young learners to make groundbreaking discoveries.

Based on the various avenues of **support**, educators need to help students apply the tools properly. As mentioned, educators receive technical and pedagogical support from a number of sources including the project partners, ITRT, and a dedicated technical support line. Just-in-time support is critical to ensure that educators feel confident to use this advanced technology with their students.

The telescope is an advanced scientific instrument that can enable teachers to plan complex and authentic activities for students. Teachers must understand how to design and facilitate appropriate experiences for their students. **Professional development**, led by an ITRT, can address these aspects in training sessions with teachers.

Tools

A good tool allows people to perform functions they would not be able to perform without it. Put simply, it extends a person's capabilities. This project extends a student's capabilities through essentially two tools: a telescope and a Web browser. Additionally, the main *Share the Skies* tool is authentic; unlike a typical classroom telescope, the telescope is research grade—the same used by professional astronomers.

The *Share the Skies* Web 2.0 tools also allow tremendous **curricular** flexibility, particularly as they promote collaboration, including wikis and other forms of shared communication. A key is that the tools can be personalized for the classroom environment and individual students.

The software generates data that support easy **accountability**. This accountability also works in reverse. Like professional research, regular feedback from users helps improve the product and fix potential problems.

All tools will malfunction at some point. Effective projects must have **support** teams in place to repair the problems as quickly as possible. *Share the Skies* has a technician on site in Australia to fix any problems that cannot be repaired remotely. Additionally, New Mexico Skies and Software Bisque work proactively to anticipate remote-access or software problems before they occur.

As with most educational technology tools, tutorials spell out a step-by-step process for using the telescope and Web browser. In addition, intensive **professional development** sessions convey how to integrate the tool effectively into instruction. The ITRT have been trained in *Share the Skies* and can help educators realize the possibilities.

Results

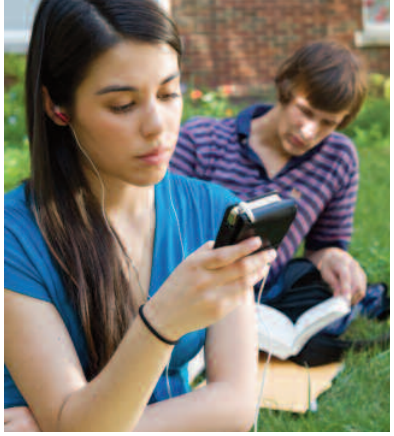
Share the Skies catalogs the work students have done, helping educators interpret achievement or possible problems. It also generates data that show students' activities in each session, which can offer insight into their thought processes.

Share the Skies can be used throughout the **curriculum** and enable students to demonstrate what they know. The tangible products from their work—digital images—could reveal their understanding on many levels. For example, the objects a student chooses to image can demonstrate his or her comprehension of magnitude (brightness of an object).

The possibilities for **accountability** reach far beyond student achievement. By studying how students learn, educators can adapt curricula to meet the changing needs of 21st century skills and knowledge.

The available data are particularly important in shaping the appropriate level of technical and pedagogical **support**. User activity logs can help technical support staff identify problems and make adjustments as needed. Poor images provide an opportunity to explore possible causes and serve as wonderful opportunities to expand teachers' understanding. The explanations could range from an inadequate exposure time to dust from the annual wheat harvest. The complexity of the process and unpredictability of the environment creates new and exciting challenges each day for teachers and students.

As noted, the project generates quantitative results for teachers and administrators. A student's 21st century skill development, however, may be less quantifiable or simple to ascertain. Educators need **professional development** to better assess the 21st century skills that students display. Training helps teachers examine the data, processes, and outcomes to recognize how well students are learning.



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Goals, Objectives, Strategies, and Evaluation Strategies

The *Educational Technology Plan for Virginia: 2009-15* imparts state-level goals and objectives grounded in a foundation of research and based on identified needs (see Appendix B). School divisions must develop locally appropriate strategies and measures that address these statewide goals and objectives while, at the same time, leveraging their unique strengths and minimizing the gaps between promise and practice. Beyond the goals and objectives of the state's plan, division technology committees may create effective plans by adding goals and objectives that support division missions and visions.

Virginia school divisions are practiced in the art and science of good planning procedures. Division technology plans need to follow these procedures, reflect state and local goals, and be useful to all stakeholders. With an increased emphasis on supportive data collection, divisions also must collect appropriate and useful information during the evaluation phase of the planning cycle.

The Virginia Department of Education has generated some tools to help divisions formulate their technology plans. An alignment document focuses on both the planning process and the plan itself (see Appendix C). Additionally, the Department has developed an outline of the educational technology data that must be collected.

Goal 1: Provide a safe, flexible, and effective learning environment for all students

Objective 1.1: Deliver appropriate and challenging curricula through face-to-face, blended, and virtual learning environments.

Strategy 1.1.1: Expand course offerings for students through Virtual Virginia.

Evaluation Strategy: Before and after, analyze the frequency counts of courses offered through Virtual Virginia.

Strategy 1.1.2: Enhance Virtual Virginia courses to promote greater flexibility and engagement for learners.

Evaluation Strategy: Describe the number and types of media enhancements to Virtual Virginia.

Evaluation Strategy: Analyze the user assessments of flexibility and engagement.

Strategy 1.1.3: Provide statewide access to Web-based content, tools, and collaborative spaces.

Evaluation Strategy: Analyze use data to determine frequency of access to Web-based content, tools, and collaborative spaces.

Strategy 1.1.4: Leverage higher education partnerships to assist schools in instructional design and media production.

Evaluation Strategy: Document how the number and types of higher education partnerships differ from previous years.

Evaluation Strategy: Describe the types, quantity, and perceived quality of instructional and technical assistance provided by higher education partnerships.

Evaluation Strategy: Describe the extent to which these partnerships are accessible and useful with regard to delivering appropriate and challenging curricula.

Evaluation Strategy: Document the professional development program attendance and perceived quality.

Objective 1.2: Provide the technical and human infrastructure necessary to support real, blended, and virtual learning environments.

Strategy 1.2.1: Provide resources and support for one instructional technology resource teacher (ITRT) per 1,000 students to assist teachers in integrating technology into teaching and learning.

Evaluation Strategy: Document the resources and support provided by the state to reach this objective.

Evaluation Strategy: Describe the ratio of ITRT to students by school division.

Evaluation Strategy: Describe the extent to which the actual count matches the *one ITRT per 1,000 students* guideline.

Strategy 1.2.2: Provide resources and support for one technical support position per 1,000 students to ensure that technology and infrastructure is operational, secure, and properly maintained.

Evaluation Strategy: Document resources and support provided by the state to reach this objective.

Evaluation Strategy: Describe the ratio of technical support personnel to students by school division.

Evaluation Strategy: Describe the extent to which the actual count matches the *one technical support position per 1,000 students* guideline.

Strategy 1.2.3: Facilitate the implementation of fiber and 100 Mbps to 1 Gbps Ethernet to every school.

Evaluation Strategy: Describe state-level efforts to facilitate this objective.

Evaluation Strategy: Describe the extent to which fiber and 100 Mbps to 1 Gbps Ethernet have been implemented in every school.

Strategy 1.2.4: Facilitate the implementation of wireless access to the Internet in every school.

Evaluation Strategy: Describe state-level efforts to facilitate this objective.

Evaluation Strategy: Describe the extent to which wireless access has been implemented in every school.

Objective 1.3: Provide high-quality professional development to help educators create, maintain, and work in a variety of learner-centered environments.

Strategy 1.3.1: Identify, develop, disseminate, and maintain resources to support the effective use of technology in all curricula by teachers at all levels of integration expertise.

Evaluation Strategy: Examine the extent to which the state identifies, develops, disseminates, and maintains the resources needed to support the effective use of technology across curricula and at varying levels of integration expertise.

Strategy 1.3.2: Leverage public/private/nonprofit partnerships to provide professional development focused on technology integration strategies and the development of teachers' and administrators' 21st century skills.

Evaluation Strategy: Document how the number and types of partnerships differ from previous years.

Evaluation Strategy: Describe the types, quantity, and perceived quality of professional development provided by partnerships.

Evaluation Strategy: Describe the extent to which these partnerships focus on technology integration and 21st century skills.

Evaluation Strategy: Document the professional development program attendance.

Strategy 1.3.3: Support pilot projects to help educators better understand the impact of new and emerging technologies on the learning environment and develop strategies to integrate them effectively into schools.

Evaluation Strategy: Document the state's efforts to support pilot projects.

Evaluation Strategy: Describe the number, types, locations, and scope/extent (breadth and depth) of the pilot projects.

Evaluation Strategy: Document the new and emerging techologies and strategies for technology integration in schools.

Goal 2: Engage students in meaningful curricular content through the purposeful and effective use of technology.

Objective 2.1: Support innovative professional development practices that promote strategic growth for all educators and collaboration with other educators, content experts, and students.

Strategy 2.1.1: Facilitate the development or use and delivery of innovative professional development that promotes collaboration.

Evaluation Strategy: Describe the development of professional development opportunities.

Evaluation Strategy: Describe the types, scope/extent, and accessibility of the professional development offered.

Evaluation Strategy: Describe the extent to which these opportunities facilitate the development or use and delivery of innovative professional development that promotes collaboration.

Evaluation Strategy: Document the professional development program attendance.

Strategy 2.1.2: Facilitate the development and delivery of professional development opportunities that focus on effective technology use in specific core curricular areas.

Evaluation Strategy: Describe how the state facilitates professional development opportunities.

Evaluation Strategy: Describe the development of professional development opportunities for each core curricular content area.

Evaluation Strategy: Describe the types, scope/extent, and accessibility of the professional development offered.

Evaluation Strategy: Document the professional development program attendance.

Objective 2.2: Actualize the ability of technology to individualize learning and provide equitable opportunities for all learners.

Strategy 2.2.1: Provide reasonable access to Internet-connected devices that offer students the flexibility to learn anytime, anywhere.

Evaluation Strategy: Describe the state's role in providing access to Internet-connected devices.

Evaluation Strategy: Tabulate the number of Internet-connected devices per student by division, locality, and grade level.

Evaluation Strategy: Describe access policies.

Evaluation Strategy: Describe student use records.

Strategy 2.2.2: Identify and disseminate information and resources to assist schools in evaluating the interactive and universal design features of hardware, software, and Internet sites.

Evaluation Strategy: Describe ways the state identifies and disseminates hardware, software, and Internet evaluation information.

Strategy 2.2.3: Identify and disseminate information and resources to assist schools in developing and maintaining personal learning plans for all students.

Evaluation Strategy: Describe ways the state assists schools in developing personal learning plans.

Evaluation Strategy: Describe methods of information dissemination.

Objective 2.3: Facilitate the implementation of high-quality Internet safety programs in schools.

Strategy 2.3.1: Identify and disseminate best practices and resources to promote the integration of Internet safety and security throughout the curricula.

Evaluation Strategy: Describe methods of identifying best practices with regard to Internet safety and security.

Evaluation Strategy: Describe the best practices identified and methods of information dissemination.

Strategy 2.3.2: Monitor the implementation of Internet safety policies and programs and provide technical assistance and support to ensure that schools have effective programs and policies.

Evaluation Strategy: Describe monitoring methods.

Evaluation Strategy: Describe the types and availability of technical assistance and support.

Goal 3: Afford students with opportunities to apply technology effectively to gain knowledge, develop skills, and create and distribute artifacts that reflect their understandings.

Objective 3.1: Provide and support professional development that increases the capacity of teachers to

design and facilitate meaningful learning experiences, thereby encouraging students to create, problem-solve, communicate, collaborate, and use real-world skills by applying technology purposefully.

Strategy 3.1.1: Identify and disseminate information and resources that help schools provide ongoing, personalized, and just-in-time professional development for teachers implementing technological and pedagogical innovations.

Evaluation Strategy: Describe the identification of resources.

Evaluation Strategy: Describe the dissemination of information.

Evaluation Strategy: Describe the extent to which these information sources are accessible and useful with regard to giving ongoing, personalized, and just-in-time support.

Strategy 3.1.2: Enhance curricula using Internet resources and software that encourage creativity, collaboration, and problem solving.

Evaluation Strategy: Describe curriculum enhancement (list of Web resources and software, including their instructional objectives).

Evaluation Strategy: Describe the availability of resources.

Evaluation Strategy: Describe access to these resources.

Strategy 3.1.3: Promote the safe and responsible use of social media.

Evaluation Strategy: Describe the state's efforts to promote safe and responsible use of social media.

Strategy 3.1.4: Provide opportunities for students to participate in global communication and collaboration.

Evaluation Strategy: Describe the state's efforts to provide students with opportunities to participate in global communication and collaboration.

Strategy 3.1.5: Identify and disseminate resources to help school boards and administrators develop and evaluate technology policies that effectively balance the need for instructional innovation with safety and security.

Evaluation Strategy: Describe the identification and dissemination procedures that help school boards develop and evaluate technology policies.

Objective 3.2: Ensure that students, teachers, and administrators are ICT literate.

Strategy 3.2.1: Identify and disseminate information and resources to ensure that schools can effectively assess and report ICT literacy.

Evaluation Strategy: Describe the identification and dissemination procedures that help school boards develop and evaluate technology policies.

Strategy 3.2.2: Monitor the assessment of ICT literacy in schools and provide technical assistance and support to schools as needed.

Evaluation Strategy: Describe the monitoring processes.

Evaluation Strategy: Describe the technical assistance efforts.

Evaluation Strategy: Describe the support efforts with regard to helping localities find resources to assess ICT literacy.

Strategy 3.2.3: Provide and support high-quality professional development focused on the acquisition and application of ICT skills for teaching, learning, and school management.

Evaluation Strategy: Describe the development of ICT-related professional development for teaching, learning, and school management.

Evaluation Strategy: Describe the types, scope/extent, accessibility, and perceived quality of the professional development offered.

Evaluation Strategy: Document the professional development program attendance.

Strategy 3.2.4: Provide opportunities for teachers and students to learn to deconstruct and construct media messages.

Evaluation Strategy: Describe the opportunities provided to teachers and students to deconstruct/construct media messages.

Evaluation Strategy: Document the state-recommended media literacy guides.

Objective 3.3: Implement technology-based formative assessments that produce further growth in content knowledge and skills development.

Strategy 3.3.1: Identify and disseminate information about technology tools and systems to help schools implement cognitively-based assessments.

Evaluation Strategy: Describe the identification and dissemination process for technology tools and systems that facilitate cognitively-based assessments in schools.

Strategy 3.3.2: Design and implement pilot projects to explore technology-based assessment models that tightly integrate curricula, instruction, and assessment.

Evaluation Strategy: Describe the processes of designing the pilot programs.

Evaluation Strategy: Describe the number, types, locations, and scope/extent (breadth and depth) of the pilot projects.

Evaluation Strategy: Document the projects' strategies for integrating curricula, instruction, and assessment into schools.

Goal 4: Provide students with access to authentic and appropriate tools to gain knowledge, develop skills, extend capabilities, and create and disseminate artifacts that demonstrate their understandings.

Objective 4.1: Provide resources and support to ensure that every student has access to a personal computing device.

Strategy 4.1.1: Provide tools that extend students' capabilities, can be customized to meet individual needs and preferences, and support learning.

Evaluation Strategy: Determine the frequencies of personal computing device distribution, specifically (a) how personal computing devices are customized and (b) how the options for customization support learning.

Strategy 4.1.2: Provide opportunities for students to learn and apply ICT skills in local and community settings using a variety of authentic tools.

Evaluation Strategy: Describe how and the extent to which the state provides students with opportunities to learn and apply ICT skills; describe the programs designed to teach students about ICT skills.

Objective 4.2: Provide technical and pedagogical support to ensure that students, teachers, and administrators can effectively access and use technology tools.

Strategy 4.2.1: Provide and support high-quality professional development to assist educators in evaluating and integrating technology tools in ways that foster effective student use.

Evaluation Strategy: Describe the state's role in providing professional development opportunities.

Evaluation Strategy: Describe the types, scope/extent, and accessibility of the professional development offered.

Evaluation Strategy: Describe how the professional development assists educators in evaluating and integrating technology tools in ways that benefit student learning.

Evaluation Strategy: Document the professional development program attendance.

Strategy 4.2.2: Provide ongoing just-in-time support to assist teachers in effectively integrating a variety of technology-based tools into teaching and learning.

Evaluation Strategy: Describe the state's role in providing ongoing and just-in-time support.

Evaluation Strategy: Describe the types of ongoing and just-in-time support and how they assist educators in evaluating and integrating technology tools in ways that benefit student learning.

Strategy 4.2.3: Provide timely and effective technical support to ensure that all tools and the network that supports them are installed and maintained properly.

Evaluation Strategy: Describe the state's role in providing technical support.

Evaluation Strategy: Describe the types of technical support available.

Evaluation Strategy: Describe the extent to which technical support is timely and effective with regard to technology installation and maintenance.

Objective 4.3: Identify and disseminate information and resources that assist educators in selecting authentic and appropriate tools for all grade levels and curricular areas.

Strategy 4.3.1: Identify and disseminate information about new and emerging technologies.

Evaluation Strategy: Describe methods of identifying and disseminating information about new and emerging technologies.

Strategy 4.3.2: Design and implement pilot projects to evaluate a variety of personal computing devices.

Evaluation Strategy: Document the state's efforts to support pilot projects.

Evaluation Strategy: Document the processes of designing and implementing the pilot projects.

Evaluation Strategy: Describe the number, types, locations, and scope/extent (breadth and depth) of the pilot projects.

Evaluation Strategy: Describe the methods of the pilot projects for evaluating personal computing devices.

Goal 5: Use technology to support a culture of data-driven decision making that relies upon data to evaluate and improve teaching and learning.

Objective 5.1: Use data to inform and adjust technical, pedagogical, and financial support.

Strategy 5.1.1: Model the use of data to inform strategic plans and purchases.

Evaluation Strategy: Describe how the state uses data to inform strategic plans and purchases.

Evaluation Strategy: Describe how the state models data use to divisions and locales to inform strategic plans and purchases.

Strategy 5.1.2: Conduct an annual survey and provide local education agencies with an annual statewide technology status report.

Evaluation Strategy: Document when, where, and how the survey is conducted.

Evaluation Strategy: Document the dissemination of survey results.

Objective 5.2: Provide support to help teachers disaggregate, interpret, and use data to plan, improve, and differentiate instruction.

Strategy 5.2.1: Provide training and support to help ITRT interpret data and assist teachers in using technology effectively to address data-supported needs.

Evaluation Strategy: Describe the state's role in providing ITRT training.

Evaluation Strategy: Describe the types, scope/extent, and accessibility of the professional development offered.

Evaluation Strategy: Describe how professional development enables ITRT to use student achievement data to help teachers use technology in ways that optimize student learning.

Strategy 5.2.2: Identify and disseminate resources to assist ITRT in training teachers to disaggregate, interpret, and use data for instructional improvement.

Evaluation Strategy: Describe the types of resources disseminated.

Evaluation Strategy: Describe the dissemination processes.

Evaluation Strategy: Document how these resources help ITRT use student achievement data to inform teachers about ways to improve instructional technology to enhance student learning.

Objective 5.3: Promote the use of technology to inform the design and implementation of next-generation standardized assessments.

Strategy 5.3.1: Design and implement pilot projects that support technology-based assessments, including simulations and game environments, innovative delivery platforms, and multiple ways for students to demonstrate understanding.

Evaluation Strategy: Describe the processes of designing the pilot programs.

Evaluation Strategy: Describe the number, types, locations, and scope/extent (breadth and depth) of the pilot projects.

Evaluation Strategy: Describe the technology-based assessments that are developed.

"A learning environment has to be structured to achieve the ultimate goal of education: the educated person."

—Ibrahim Hefzallah

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Grounding the Framework in Research

Environment

The first step in supporting student learning is establishing an effective learning environment. The identification of 21st century skills and the rapidly changing nature of technology—which demand and support these skills—require schools to adapt their traditional approaches to environments.

In the recent past, the student environment often consisted of traditional school desks, cheerful classrooms with bright (but static) bulletin boards, and group spaces—like cafeterias and auditoriums—where the whole school could gather. Such environments supported monolithic methods of instruction, as teachers led students step-by-step through each subject area and grade level.

The term *environment* now addresses much more than classrooms; it refers to the extended classroom, which can range from museums, to local ponds, to virtual reality, to blended environments that combine physical spaces with the virtual world. Sharon Smaldino, Deborah Lowther, and James Russell (2008) define a learning environment as the "learning setting," comprising "physical surroundings in which learning is expected to take place"; this can include "the classroom . . . the laboratory (computer lab, science lab, or language lab), library, media center, playground, field trip site, theatre, study hall, and at home" (p. 16).

In the National Research Council's report, *How People Learn*, an effective learning environment is described as learner-centered, assessment-centered, knowledge-centered, and community-centered. Learner-centered environments consider the knowledge, skills, and attitudes that students bring to the classroom. A knowledge-centered environment considers what is taught, why it is taught, and what mastery looks like. In the assessment-centered environment teachers employ ongoing formative assessments to monitor and demonstrate student progress, enable students to revise and improve their thinking, and help them identify problems that need to be addressed. Finally, the community-centered environment establishes norms for the classroom and makes connections to the world beyond the classroom to support core-learning values (Bransford, Brown, & Cocking, 2000). Technology, when used effectively, can help create and support this type of learning environment.

Technology integration has required educators to look at nontraditional physical space issues, such as organizing desks in computer labs to maximize learning, installing proper chairs and monitors to reduce back and eye strain, and instructing students to take regular breaks to avoid repetitive stress syndrome. Technology integration, with its emphasis on teamwork and multiple activities, also has encouraged the use of classroom stations and areas where students can collaborate. These concepts have been important leaps forward for classrooms, which have been laid out based on essentially the same approach since the days of one-room schoolhouses.

To support technology use in learning 21st century skills, the physical environment definition must be extended to address infrastructure, including wires, connections, computers, and displays. Infrastructure comprises everything from physical equipment to human resources, the availability of outlets to timely technical support. To be robust, this environment must be adequately flexible to adapt as technology changes. Additionally, environments must be safe; this includes hardware and software interventions, teacher monitoring of activity, and student education on healthy behavior.

Technology also extends teaching and learning beyond the structured hours of the school day, providing a 24-hour-a-day opportunity to access resources and information (Harwood & Asal, 2007). This unprecedented blending of technology and the learning environment is, in the broadest sense of the term, multidimensional—spanning both space and time; yet, each school-based environment must reflect the values, mores, and characteristics of a particular community in a particular historic time. Proper policies and procedures provide needed grounding for students.

Flexible and Equitable

To state the obvious, the future of technology is exponentially unpredictable. Technology resources in school buildings must be adequately *flexible* to adapt easily to changes. Students currently have access (not exclusively in schools) to innumerable technologies that allow them to acquire knowledge and generate products. These technological possibilities will increase dramatically in number and variety over the next six years.

In the world of technology, the term *learning environments* holds nearly limitless possibilities. Physical spaces can be reconfigured temporarily depending on the changing needs of students, such as when they need to work individually or collaboratively (Brodersen & Iversen, 2005). Even the physical walls are no longer limited to being static surfaces; special *paint* can convert them into projection surfaces, and increasingly thinner and larger displays and televisions are transforming surfaces that define physical spaces.

K-12 schools are beginning to look at *smart spaces*—open environments that intuitively provide appropriate tools depending on the students' demonstrated skills and specific tasks. Such flexibility is

possible because miniscule technological equipment now can contain exponentially more computation capability than super computers of the recent past. As Bill Mark (2001) notes, this makes decision making about computation "more about spaces than devices" (p. 52).

Wireless devices—particularly handheld and laptop computers—and small devices, such as tiny palm-sized projectors, make it easier to reconfigure spaces. Mobile learning offers tremendous flexibility (Li, Lau, Shih, & Li, 2008). GPS receivers and other sensors can factor a learner's location and enable the learning environment to respond to a command or request. Relevant information or activities can be delivered to the student's relative position within that physical environment.

Cognitive scientists and 21st century skills experts have called for technologically supported environments that enable students to learn—underscoring the importance of technology availability and access. The gap between students and access to technology-based resources, called the *digital divide*, has been a concern since the launch of technology in schools (Davis, Fuller, Jackson, Pittman, & Sweet, 2007). Technology generates new levels of inequality among students outside of school; those from a higher-income family or with a higher achievement level have more opportunities to interact with technology than students from a lower economic status (Brown-L'Bahy, 2005; Davis, Fuller, Jackson, Pittman, & Sweet, 2007).

The issue, however, is not merely one of access but how the technology is used (McGrath, 2004). Placing students in technologically rich learning environments fosters additional use of such tools and helps level the playing field (Schroeder & Zarinnia, 2007). The flexibility of technology provides a learning environment in which students can select the tools most appropriate to their needs and comfortable to their learning styles (Kelly, 2008).

Project *ROAR*: *Opening New Worlds of Learning*

Project *ROAR*, a Radford University initiative, develops augmented reality learning simulations that enhance middle school science teaching and learning in southwestern Virginia. The project effectively blends the real and virtual environments. It uses handheld computers and GPS receivers to correlate students' real-world locations to their virtual locations in the simulation's digital world. As students move around a physical location, such as playgrounds or sports fields, maps on their handheld devices superimpose digital objects and virtual people from the augmented reality on real space. When students come within approximately 10 feet of these digital artifacts, video, audio, and text files provide narrative, navigation, and collaboration cues as well as academic challenges. This technology helps students break down classroom walls and expand their learning environment as far as their minds can take them.

Most importantly, the environment should be developed around the needs of the school, the subject and content to be taught, and specific goals and objectives (Hefzallah, 2004; Kelly, 2008; Price, 2007). Schools need to become empowered to design and develop such learning environments.

Learner Centered and Social

Howard Gardner (1993, 1999) posits that students have multiple intelligences, though they generally do not excel in more than a few. Within these intelligences, they possess different *learning styles*. In the past, some of these students, such as visual learners or kinesthetic learners, have found it more difficult to adapt to conventional classroom settings. Technology allows students to use tools that best suit their learning styles and interests and that prepare them to continue their learning beyond school.

This characteristic of a technology-enabled environment supports a learner-centered approach to education, validated by 21st century skills scholars and cognitive science researchers (Bransford et al., 2000; Gee, 2003; Hefzallah, 2004). Learner-centered environments facilitate connections between students' existing knowledge, skills, and attitudes and the current learning situation (Bransford et al., 2000). Technology can help create an environment where students can solve real-world problems that are meaningful to them. Other aspects of the learner-centered approach are pace and timing. Technology again allows students to determine the pace that best suits their learning styles and access learning at any time and in any place. Placing the responsibility for learning on students and providing them with the proper tools, they will learn how to learn for the rest of their lives.

Ironically, in a student-centered environment, the teacher is more important than ever. Lejeane Thomas and Don Knezek (2002) state, "The key individual in helping students develop [technology] capabilities is the classroom teacher. . . . The teacher is responsible for establishing the classroom environment and preparing the learning opportunities that facilitate student use of technology to learn, communicate, and develop knowledge products" (p. 16). Teachers who know how to leverage the learning power of technology are essential to student-centered learning.

While textbooks can be valuable resources, they clearly have limitations. "Few resources are more prevalent in schools in textbooks; yet in many cases, textbooks inadequately address the needs of students and teachers. Outdated information is common due to the nature of textbook adoption cycles, and the information is often ill-suited to curricula and assessments. Printed textbooks containing inaccuracies often remain in use for six to eight years and literally pages of corrections are being posted to publishers' Web sites." (McGraw & Ross, 2001, p. 5). Furthermore, many textbooks do not support the learning of 21st century skills. Virginia is currently exploring traditional textbook alternatives such as the *flexbook*, a free and open-source textbook platform where one can build and edit collaborative textbooks as a means to address these issues.

ICT allows students to learn foundational knowledge and high-level skills in ways that help them the most. Intangible characteristics of an ICT environment are based on a pedagogy that supports 21st century learning. It includes the environment's ability to enable learner-centered activity (focusing on individuals with reasonable physical and virtual access to technology) and community interaction (focusing on social groups that gain physical and virtual space for using ICT). Effective technology integration "transforms the learning environment so that it is student-centered, problem and project centered, collaborative, communicative, customized and productive" (CEO Forum, 2001, p. 5).

The social aspects of learning have not been universally emphasized in current educational practice. However, research shows that "(m)uch of what humans learn is acquired through discourse and interactions with others. For example, science, mathematics, and other domains are often shaped by collaborative work among peers. Through such interactions, individuals build communities of practice, test their own theories, and build on the learning of others." (Pellegrino, Chudowsky, & Glaser, 2001, p. 5). By creating environments that encourage and enable these social dimensions, technology provides for deeper learning.

Contextual, Dynamic, and Safe

A flexible environment allows teachers to respond more adroitly to individual student needs. Since technology can connect students to a world outside their classrooms, it can foster learning in the *context* of real-world situations and opportunities. A lesson may be grounded in local political issues or a worldwide environmental crisis. Mobile technology allows students to move out into their community to investigate, gather data, test hypotheses, and deliver conclusions to concerned parties. Videoconferencing capabilities allow students to interact in real time with scientists studying the desertification of equatorial countries or with archaeologists at an excavation site in Jamestown.

Students learn within the context of the local mores and standards. The community and school must influence the environment in which students are learning. The community's standards should influence the rules and regulations around the use, or misuse, of technology. A school's specific learning goals and objectives strengthen the technology environment, which, in turn, reinforce the curriculum.

Technology-enhanced environments must also remain *dynamic*—open to change and the influx of new enabling technologies. These newer technologies can motivate students to learn more and push themselves harder. In this area, technology environments can learn from areas such as gaming. The Learning Federation (2003) identified five components in its *Learning Science and Technology R&D Roadmap*. Among the components related to instructional design for new technology-enabled approaches to learning is "understanding how features of games can be used to improve learning" (p. 9). James Paul Gee (2003) suggests, "When kids play video games they experience a much more powerful form of learning than when they're in the classroom. . . . The secret of a video game as a teaching machine isn't its immersive 3-D graphics, but its underlying architecture. Each level dances around the outer limits of the player's abilities, seeking at every point to be hard enough to be just doable" (p. 68).

Just as student *safety* is important in the physical learning environment, it is equally essential in any virtual learning environment. Educators must regularly emphasize responsible technology use, going beyond the obvious use of filters and restrictive policies to achieve student self-awareness and self-control. In physical and virtual environments, educators are responsible for protecting students; in upper grade levels, this responsibility should gradually shift to the students. Technology that connects people from all over the world requires students to work sensitively with others and become aware of their own vulnerabilities.

Ultimately, learning environments are much different than they were 25 years ago. The increased emphasis on collaboration, student responsibility for learning, communication, access to higher levels of information, and critical thinking has permanently changed the traditional learning environment (Niess, Lee, & Kajder, 2008). The environment must take these factors into account and allow room for change while providing students with real-world contexts.

A dynamic, flexible, and authentic environment is essential to student learning in the 21st century. Ibrahim Hefzallah (2004) states, "We learn to drive a car by being behind the wheel and driving the car, not by reading about it. We learn to speak a foreign language by speaking the language. . . . We learn by taking an active role in life situations" (p. 47). To accomplish this, technology can help make the instruction environment flexible, dynamic, learner centered, contextual, social, and intelligent.

"The first object of any act of learning, over and beyond the pleasure it may give, is that it should serve us in the future. Learning should not only take us somewhere; it should allow us later to go further more easily."

—Jerome S. Bruner

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Grounding the Framework in Research

Engagement

Engaging students is one of the most frequently stated and vaguely understood phrases in education. It is used variously in reference to capturing students' attention, sparking their interest in a topic, or connecting with them on an important point. In reality, *engagement* can refer to any of these definitions; but, most importantly, engagement means helping students find relevance in a lesson in their everyday lives. To this end, teachers must help students understand how to tackle an assignment and discriminate—in short, how to learn.

Through his school-reform center, Phil Schlechty (2000) has shown that students become more engaged in their learning when it is more personal and meaningful. He has identified five levels of engagement:

1. Engagement—high attention and high commitment
2. Strategic compliance—high attention but low commitment
3. Ritual compliance—low attention and low commitment
4. Retreatism—no attention and no commitment
5. Rebellion—diverted attention

While students may arrive in the classroom with a pre-defined or preconceived level of engagement, Schlechty has found that an attention-grabbing lesson can increase this level. In fact, he has identified a direct correlation between an effectively designed activity and a student's engagement level.

Although ICT may be used somewhat passively to teach foundational knowledge, its interactive capabilities support 21st century skills most effectively. Most ICT—but especially new tools—facilitate engagement or interaction between humans and technology and between humans and humans.

Culturally Situated Design Tools

This program helps students learn standards-based mathematics in the context of various cultures, including African, African American, Native American, Latino, and a general youth subculture. Students use mathematics to simulate original artifacts from these cultures and develop their own creations. For example, the Cornrow Curves software lets students use the geometric principles of translation, rotation, reflection, and dilation while creating African American cornrow hair designs on the computer. Another software helps students learn about Cartesian coordinates while designing traditional Alaskan baskets. Contextual programs like this help engage learners by personalizing and making the experiences relevant.

Neomillennial students are no longer satisfied with obtaining all their information from textbooks or instructors; rather, these "*digital* students learn in classrooms where the technology is a seamless component of learning that expands the educational environment beyond the classroom walls and beyond the existing capabilities of learners" (Smaldino, Lowther, & Russell, 2008, p. 335).

Any technology plan must offer support for student equipment use. Schools and surrounding communities increasingly support student engagement with technology by extending opportunities for equipment use. They have attempted to bridge the digital divide by allowing after-school access to computers; partnering with public libraries and other facilities to provide computer access; or collaborating with local higher education institutions to gather and use equipment, services, and support (Cuban & Cuban, 2007). These types of opportunities cultivate personal and meaningful learning as students gain self-reliance and problem-solving skills.

A significant challenge is that children all too frequently accept any information fed to them. In this media-intensive world, that information can be extremely unreliable and, in some instances, potentially harmful. As part of learning to engage, students must learn how to examine material and deduce good from biased information. They also must be engaged in authentic learning, allowing them to become partners in the teaching process.

The literature on 21st century skills makes several points clear. First, learners must be prepared to collaborate and communicate successfully with others. Second, they should be capable of using their resources and engage in problem solving with all available resources. Third, beyond learning mere content, learners must be able to interact with and transfer knowledge in multiple situations (Conference Board et al., 2006; CEO Forum, 2001; Partnership for 21st Century Skills, 2007).

Personal and Interactive

A key aspect of engagement is that teachers must choose the appropriate technology to fit each student's life and learning style. This *personal* approach must be geared to how students want to learn. The learning process for each student is unique. Students should be allowed to help craft the learning experience to make it their own.

Web 2.0 technologies, in particular, enable students to personalize the content and media to reflect their preferences. Students are no longer just content consumers; they now have become content producers through podcasts, digital videos, etc. *YouTube* is the most high-profile example of this shift.

Personalizing the learning experience connects naturally with interdisciplinary teaching, in which educators can approach the same basic knowledge or skill set through various subjects. For instance, students can learn about basic mathematics principles through a work of art or one of their favorite songs. The students' personal interests can be a learning portal.

As noted in the Environment section, ICT has expanded the learning environment beyond physical walls. This fundamentally changes the environment into an interactive factor rather than a passive factor and opens a vast assortment of engagement opportunities, including virtual worlds for project collaboration, touch-sensitive screens, flexible projection surfaces, and works of art with attached radio transmitters that send information directly to students' handheld devices. Teachers and students now have access to more informational resources, learning communities, multimedia presentations, and other content and communications tools through the Internet and other ICT.

The addition of technology to learning environments contributes an added element of student engagement and becomes critical in the development of higher-order thinking skills. Technology and media present different characteristics (beyond traditional teaching tools) and allow students to learn according to their preferences (Hefzallah, 2004). This generation is more aware of what it wants from education. Educators must ensure that each student has an equal opportunity to learn (U.S. Department of Education & Office of Educational Technology, 2004).

Universal Design and Adaptivity

Universal design has existed in architecture and city planning for years, advanced significantly by the Americans with Disabilities Act. Universal design generally refers to construction (e.g., buildings, sidewalks) that accommodates people of all abilities (e.g., wider doorways for wheelchairs, standardized

placement of signage). It has the same definition in education; although, accommodating a diverse student population requires numerous approaches in the same classroom. Total equity largely was impossible in the past. Educational technology, however, allows teachers literally to program a different lesson for each student based on individual learning needs, cultural backgrounds, and personal interests. In short, universal design for learning is not limited to special education; it is about differentiating instruction for all students.

In 1998, Congress amended the Rehabilitation Act to make electronic and information technology more accessible to people with disabilities. Section 508 of the Rehabilitation Act requires federal agencies to eliminate accessibility barriers and utilize technologies that help individuals with disabilities use the Internet and other electronic resources. In 2004, Congress revised the Individuals with Disabilities Education Act (IDEA), further strengthening the rights of people with disabilities. The Commonwealth of Virginia is committed to making all educational resources—electronic and printed—accessible to the entire student population.

The essence of Section 508 and IDEA is that individuals with disabilities should have equitable learning experiences. In this sense, technology can play a critical role. One piece of equipment can meet the diverse needs of multiple students, thus providing choices (Hefzallah, 2004). This is a key feature of most assistive technologies. For example, tangible user interfaces can be effective with younger children or children with special needs. These interfaces permit direct physical manipulation and are much different than graphical user interfaces on desktop systems, which rely primarily on the keyboard and mouse. Other recent developments are touch and gesture-based interfaces such as those found on the iPhone and iPod touch.

Another benefit of technology is its *adaptivity*. Unlike textbooks, most educational technology is not a one-way communication medium. Technology typically is interactive in the sense that students do not just receive information but also can adapt, interpret, or improve upon it. This interactivity can occur in real time, so students learn when and where they are ready.

Collaborative

The ultimate purpose of education is to prepare students for life and work, which means education requires more team-based opportunities. In the past, team-based activities were limited and generally restricted to classrooms or schools; the *collaborative* possibilities now are unlimited.

Cognitive science research (Bransford et al., 2000) shows that students learn better when they participate in group-learning activities. Technology provides a means by which students—whether they are classmates or students from different countries—may work in groups. Many tools can be used collectively to brainstorm, create, edit, and share artifacts, expertise, and knowledge.

The Internet allows students to team with individuals from around the world, ranging from other young people to experts on various topics. Environments that include collaborative teaching strategies, such as cooperative learning groups, encourage students to engage with other students and the learning materials. Students increasingly are learning from one another in teams facilitated by a guiding teacher and an intermediary technology.

Web-based tools allow students to collaborate beyond their classrooms or schools. Web and videoconferencing tools support communication, while tools such as *Zoho* enable students to produce and share documents—and even edit collaboratively in real time. Oracle has developed Thinkquest.org to connect students from all over the world in short- and long-term projects; these powerful collaboration tools are based on real-life models used by scholars and scientists. With technology, students need not occupy the same space, or even the same time zone, to work with one another to increase their learning.

Wikipedia is another good example of collaboration. A wiki allows students to contribute to the collective intelligence by collaborating with others to refine content and information on a continual basis. Rather than resist Wikipedia due to possible inaccuracies, schools can use this tool to teach students how to review information critically and disseminate their own research and writing.

Web 2.0 technologies can support proven teaching strategies that encourage student engagement and interaction. These strategies include problem-based and cooperative learning, which promote personal connections, student responsibility, and social interaction (Herrington & Kervin, 2007; Jonassen, Howland, Moore, & Marra, 2003; Smaldino, Lowther, & Russell, 2008).

Social networking tools can allow students to identify, interact, and collaborate with one another. While most reporting focuses on the negative aspects of social networking, schools need to embrace these outlets and find meaningful ways to incorporate them. One possibility is online portfolios, which mirror the way students use sites like *MySpace* and *Facebook*—in other words, these sites present students' interests and profiles, identify people with similar interests, and allow them to interact with one another. Online portfolios take the same approach but present students' academic profiles.

Some educators have misinterpreted the concept of integrating technology as merely using e-mail to communicate with parents, developing a class Web page, maintaining grades electronically, or using PowerPoint in a classroom presentation. While these tasks are important, they neither constitute technology integration nor student engagement (Smith, Bichelmeyer, Monson, & Horvitz, 2007). True engagement requires students and teachers to apply appropriate technology to learning situations. It requires technology that can be personalized and adapted to individual students and that provides interactive and collaborative experiences.

"All our steps in creating or absorbing material of the record proceed through one of the senses—the tactile when we touch keys, the oral when we speak or listen, the visual when we read. Is it not possible that some day the path may be established more directly?"

—Vannevar Bush, 1945

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Grounding the Framework in Research

Application

In the context of the six-year plan, the term *application* does not refer to software specifically but how the software is *applied*. A typical problem is that people often become familiar with a certain software title and try to apply it to every situation. Students need to learn how to analyze a problem and then select the proper tool (see Tools section). For example, although it would function, Microsoft Word is not the most appropriate program for designing a multimedia project with photographs. Likewise, students do not need PhotoShop just to generate a basic text document.

Under the goals of the previous six-year technology plan, teachers and students became familiar with the characteristics of different software programs. Current technology, however, offers a much wider array of choices to students. For instance, wikis provide word-processing capabilities that rival the basics of Microsoft Word, but the document is stored online and can be coedited by others.

As teachers become familiar with the capabilities of equipment, they must employ knowledge of human learning to make informed pedagogical decisions about the application and use of the tools (Hefzallah, 2004). Mark Warschauer states, "What is more important about [technology] is not so much the availability . . . but rather people's ability to make use of that device . . . to engage in meaningful social practices" (Harwood & Asal, 2007, p. 82).

This shift in roles requires continual professional development to keep teachers up-to-date and adequately prepared. Maggie Niess, John Lee, and Sara Kajder (2008) argue that continual learning and preparation are the "keys for assuring educational reform that adequately prepares students to meet the challenges of the twenty-first century" (p. xiv). As such, teachers "must consistently engage in learning about new and emerging technologies . . . how to teach both *about* and *with* the new and emerging technologies" (p. xiv). The message is that teachers can no longer teach in the manner they were taught; they must remain as flexible and dynamic as the technology itself (Mehlinger & Powers, 2002).

Students increasingly use ICT to research any topic of interest to them, providing more opportunities to learn foundational knowledge. Armed with ICT literacy skills, students can evaluate the accuracy and value of information they discover on the Internet.

Fresh Fish on Sacred Soil: Engaging Learners on Virginia's Civil War Battlefields

A project initiated by the Virginia Department of Education Office of Educational Technology creates an environment where learners of all ages can experience Virginia's Civil War battlefields in an innovative and authentic way. It leverages GPS-enabled mobile devices, digitized primary source materials, and social media tools to promote a deep and shared understanding of the Civil War. The project allows battlefield visitors to use a variety of digital tools and media to access, contribute to, and distribute historical narratives about the Civil War. Learners can access and share text, new and historic images, audio, and video artifacts. Applying common technology tools (e.g., iPhones, GPS devices) to learning helps make the subject—in this case, the Civil War—more relevant to students. It also helps learners better understand the capabilities of everyday technology devices and how to choose the right tool for the intended purpose.

Most significantly, ICT can emulate authentic 21st century practices, such as problem solving, communication, innovation, and creativity. These skills are increasingly important in the business world. M. B. Eisenberg (2003) states that as students use technology for problem solving, they gradually will learn more about its application and potential rather than just developing isolated, discrete skills; this will help them "perform better in classroom curriculum," which is "essential if we are to put students in a position to succeed in an increasingly complex and changing world" (pp. 13-15).

Content Acquisition and Scaffolding

Some scholars assert that learning can be enhanced and even accelerated with the use of graphically-baed interactive models and simulations (Bransford, Brown, & Cocking, 2000). Learners also tend to develop deeper understandings of subjects when they participate in inquiry-based investigations of authentic problems. This presents hope and challenges since all students learn and progress in a unique manner.

Although technology is most effective in nurturing students' 21st century skills, it also can help with *content acquisition*. Not all drill-and-practice programs are mere electronic worksheets. Some software programs can respond intelligently to the users' progress and assist them in learning a concept or skill.

Regardless of the use, good ICT helps teachers provide *scaffolding* between what students already know and the acquisition of new knowledge. Eisenberg (2003) states, "Students need to be able to use technology for a purpose, flexibly and creatively"; he adds, "helping students learn to apply technology in these ways requires a major change in the way computing and technology are often taught in school" (p. 13). This means moving from teaching about isolated skills and focusing more on application.

Tools should help students move from level to level in technology learning. This scaffolding can help ease students'

transitions into more advanced technology. Educators should provide this scaffolding for each student based on individual learning styles. According to Dr. Zheng Yan (2007), "The scaffolding needs to be adjusted continually to meet individual needs, which vary based on children's physical, social, and cognitive stages as well as personalities" (p. 1).

Students' reliance on a teacher diminishes as they become increasingly comfortable with making decisions, using appropriate tools, and relying on other students to complete tasks. By offering extensive resources and collaborative opportunities, teachers can scaffold student learning experiences to "incorporate collaborative work with multiple paths to exploring ideas" (Niess, Lee, & Kajder, 2008, p. 49). As students respond to these learning situations, they will "learn to use technology as a tool for learning" (Price, 2007, p. 49), where the tool becomes *part* of the learning process, not what the learning process is *about*.

Communication and ICT Literacy

The growth of distance education is a prime example of applying ICT effectively for learning. Online and virtual courses dramatically are changing the ways students learn and interact (Smaldino, Lowther, & Russell, 2008). Distance education can accomplish a number of purposes, from solving overcrowding problems, to providing students in rural areas with more complex and challenging coursework, to educating incarcerated students (Price, 2007).

Today's students engage in national and international learning communities, using technology to break through geographical and cultural barriers, such as distance (Price, 2007). Distance education and virtual learning environments also benefit educators, who use Web 2.0 tools (e.g., webinars, blogs, discussion boards) to participate in professional development opportunities (Price, 2007; Wyatt, 2007). Betsy Price (2007) adds that technology such as the Internet provides teachers with a way to network nationally with peers. She states, "The Internet addressed this problem of isolation by bringing communities of like-minded teachers together" (p. 13).

New responsibilities come along with these new opportunities. A large part of ICT literacy is learning how to use these valuable technologies in effective, safe, and ethical ways. Students can learn to use technology on their own (as they often have), but they need the guidance and wisdom of their parents, teachers, and administrators to learn and apply the mores of their local community to their technology use.

Innovation, Creativity, and Problem Solving

Students who use technology for learning typically find that these tools help them become more innovative and better problem solvers. Technology not only enables students to learn creativity and innovation skills but also challenges them to be more inventive. For instance, a Tablet PC facilitates

simple changes and edits, which can assist students who may be hesitant to draw illustrations due to the fear of making a mistake. Students who want copyright-free music for a podcast can use GarageBand to write and record their own original compositions or find loops or other royalty-free musical artifacts online that can be combined to create unique compositions. Writers looking for innovative ways to express their ideas can turn to Thinkmap's Visual Thesaurus to map related words. Students answering a probing question posed by a peer from India can use Inspiration visual mapping software to connect ideas. These technologies are easy to learn and adapt to various ends, freeing the students' energy to tap their creativity.

Some schools actively integrate games into teaching and learning plans. Games, though often met with skepticism, allow students to take control of their learning and interact with content (Hefzallah, 2004). James Paul Gee (2005) suggests that many good principles of learning are built into video games and can empower learners, promote problem solving, and lead to deeper understanding. In addition, the navigation and decision-making opportunities engage students and increase their sense of responsibility, which fosters a more learner-centered environment. Educational simulations provide excellent hands-on practice of certain skills, just as they do in professional settings. While not all games are beneficial to learning, many mirror real-life situations and offer another medium for presenting authentic materials and opportunities to students. The decision making required in such situations can be transferred to other learning and work environments, thus increasing the chances of student success and achievement (Hefzallah, 2004; Smaldino, Lowther, & Russell, 2008).

Classroom instruction traditionally has addressed problem-solving skills but typically in an inauthentic manner, i.e., two trains leaving Cleveland at different speeds. Technology, on the other hand, allows students to address real-world problems, such as climate change or world hunger, in a collaborative and participatory manner. An excellent example is the GLOBE Program, which challenges learners through inquiry-based investigations of the environment. As John Bransford, Ann Brown, and Rodney Cocking (2000) observe, "This approach to learning is very different from the typical school classrooms, in which students spend most of their time learning facts from a lecture or text and doing the problems at the end of the chapter" (p. 195).

In helping students apply technology, educators need to consider how technology changes. The key to understanding this topic is that teachers and students must analyze a situation carefully to determine what they want the technology to accomplish, choose the right tool, and then complete the task—adapting when needed. The 21st century skills of communication, ICT literacy, innovation, creativity, and problem solving are all enhanced by the right technology applications.

"We shape our tools and afterwards our tools shape us."

—Marshall McLuhan

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Grounding the Framework in Research

Tools

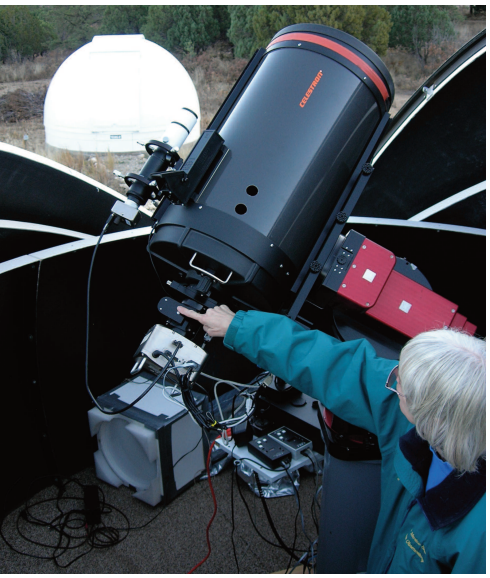
Like engagement, the term *tool* is used vaguely in the education world. In the context of this six-year plan, tool does not refer to specific hardware; rather, it is a matter of selecting the most useful means with the most appropriate characteristics to perform a particular function.

Specific technology tools often are at the forefront of major decisions, such as planning for technology purchases, dissemination, and use. Niess, Lee, and Kajder (2008) state, "Educators must continually examine the potentials of the new technologies" and decide whether the "current curriculum [will] stay the same or shift with the impact of the newer technologies" (p. 234). The latest and greatest technology tools may not fit the needs of the school, teachers, or students. In addition, since these tools change so rapidly, new purchases can become a constant drain on any school division budget.

To save time, money, and resources, it is just as important to examine existing tools and determine what can and cannot be done with them. It is important to select tools for meaningful and necessary purposes, not just because they are available (Price, 2007).

As newer technologies are brought into schools, educators often expect the new equipment automatically to perform the same or better as the old tools; however, teachers must consider several factors, such as the specificity, stability, and function of the equipment (Koehler & Mishra, 2008). As with any instruction, teaching with technology requires meticulous planning (Smaldino, Lowther, & Russell, 2008). Teachers should recognize the aptitude of their audience (students), the objective of the lesson, capabilities of the available technology, and the properties of the learning environment. In some cases, older technologies may work just as well or be more reliable. As a first step, educators should examine and try to adapt the existing tools.

While selecting the proper equipment is crucial, tools are meaningless without proper training and application (see the Application section). Training for teachers and students should support multiple levels of need. As previously stated, learning discrete and isolated skills may have significant self-efficacy purposes, but it is just as important to be trained properly on function and capability. Teacher training should focus on pedagogy and classroom application and not address issues such as maintenance and repair (Thomas & Knezek, 2002).



Educational technology plans should include tools that engage students in ways that foster 21st century skills. Such tools will adapt to different circumstances and users by changing dynamically based on needs and inputs. Tools for 21st century learners should be sufficiently intelligent to provide learners with information and experiences that fit the pace of the student rather than a predetermined program. They also should incorporate features consistent with the premise of universal design for learning which encourages the equitable use of ICT for the widest number of students possible regardless of their physical, cognitive, or emotional needs as they relate to learning.

Customizable

A tool should be *customizable*, but that does not mean adapting the wrong tool for the intended purpose, i.e., using a spreadsheet as a database. Students need to learn the benefits and limitations of a variety of tools, keeping in mind that nearly all software titles—or at least software versions—eventually become obsolete.

Hefzallah (2004) warns educators about technology fads. While certain tools may come and go with time, it is vital to consider the tool's characteristics, which are not a fad. In other words, tools may change, but the concepts behind their design and development will remain constant and transferable across time. As a result, the capabilities built into each tool can, when performed appropriately, extend the capabilities of teaching and learning.

Along this line, *mashups*—Web sites or applications that combine content from multiple sources—allow students to interact with data and information. One example is *Google Planimeter*, which computes the areas of specific places (e.g., Roanoke, Blacksburg). Another example is *Earthquakes in the Last Week*, which compiles U.S. Geological Survey data and information from *Google Maps* to show recent earthquakes measuring 2.5 or greater on the Richter Scale.

Additionally, Gee (2005) suggests that good video games achieve customizability by enabling players to shape the game play to suit their learning and playing styles. This principle is essential to empowering learners to be responsible for their own learning.

Extending Capabilities

Through the development of environments and understanding student engagement with technology, tools clearly can help *extend learning capabilities* (Price, 2007). Technology can generate added elements of functionality, access, and capabilities. According to Eisenberg (2003), when properly integrated, technology tools can help "extend knowledge and individualize learning" (p. 15). Tools manipulated at a distance, such as remote instrumentation controlled over the Internet, can

empower a learner as he or she manipulates these tools to extend the area of effectiveness (Gee, 2005).

Virtual environments, games, and simulations provide students with engaging opportunities that ultimately extend their capabilities. Virtual environments can allow students to visit places or perform tasks that would be impossible or perhaps too dangerous to visit in real life. Visualization technologies can enable students to manipulate molecular structures in their hands. In short, good learning technologies enable students to extend their capabilities in myriad ways—from analyzing, manipulating, and presenting data to accessing and exploring remote parts of the Earth.

Authentic

As educators prepare students to participate in the workforce, it is important to provide them with meaningful and realistic learning opportunities and tools (Jonassen, Howland, Moore, & Marra, 2003). Much of the available technology is equivalent or similar to equipment used in modern workplaces. Most importantly, creating opportunities for students to use and apply ICT tools to solve authentic problems will help prepare them to succeed in the 21st century workplace (Harwood & Asal, 2007; Price, 2007; Smaldino, Lowther, & Russell, 2008; Wyatt, 2007).

Technology can add several dimensions to a learning environment. These capabilities allow teachers and students to engage in authentic learning environments by having access to real-life information and realistic tools found in surrounding environments (Herrington & Kervin, 2007; Jonassen, Howland, Moore, & Marra, 2003). As students engage in authentic learning environments, they use the available tools to become active members in the authentic activities. The mere task of selecting an appropriate tool introduces students to such higher-order thinking skills as analysis, evaluation, and application (Jonassen, Howland, Moore, & Marra, 2003). In addition, student engagement in authentic learning environments encourages independence and self-reliance as well as providing practice for learning good thinking skills.

iPod touch

Effective tools should adapt dynamically to user needs and inputs. One of the best examples is the Apple iPod touch, which daily adds new educational uses—ranging from foreign languages to trigonometry—as new applications are added. These applications expand the capabilities of this versatile tool by leveraging the multitouch interface, accelerometer, Wi-Fi access, real-time 3D graphics, and other integrated features. Collectively, ordinary users and professional programmers alike have created nearly 100,000 applications for the device, many of which can be downloaded for free from the App Store. In the first 18 months of the App Store launch, more than two billion apps were downloaded. This versatile and intuitive device—coupled with an enormous collection of useful and, in many cases, user-created applications—has become an extremely popular and multipurpose learning technology.

Technology should not be used for technology's sake. Even if it is available, technology that does not fit seamlessly into a teacher's instructional plan or goals should not be used. The integration of technology must always be purpose driven and employed to enhance and extend teaching and learning capabilities. Technology should be evaluated for its ability to be customized and its authenticity. It is vital to weigh the potential *affordance* and constraints of technology in relation to goals and objectives (Koehler & Mishra, 2008). Once again, understanding the capabilities and potential of available tools is essential before planning for or integrating technology into the curriculum.

"I have not failed. I've just found 10,000 ways that won't work."

—Thomas Edison

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Grounding the Framework in Research

Results

The first four framework components lead naturally to *results*, which can be more informal and less time consuming than traditional assessments. The goal is to produce constant improvement by determining what works and what does not, thus increasing student achievement and fostering improved accountability. The key to real improvement, however, is not just assessing *what* students know but *how* they know. As stated by the U.S. Department of Education and Office of Educational Technology (2004), "Having good data to guide decisions in schools and for instruction is critical to ensuring that all the nation's children achieve. New technological solutions have the potential to generate actionable data about school performance" (p. 58).

The previous six-year technology plan focused, by necessity, on traditional assessments; however, as the need for 21st century skills has become more obvious, methods for assessing these skills must also be addressed. Technology may provide the only practical avenue for assessing these skills. As James Pellegrino, Naomi Chudowsky, and Robert Glaser (2001) write, "Technology removes some of the constraints that previously made high-quality formative assessment difficult or impractical for a classroom teacher" (p. 272).

Data-Driven Decisions

Accountability is a pressing reality for every educator. In education technology, results go beyond formal accountability systems, program evaluation, and state and federal accountability requirements and compliance. Results are rooted in *data-driven decisions*, which consist of using concrete data—increasingly acquired in real time—to inform the teaching process.

Technology can enable schools and divisions to collect higher-quality data to help educators track students from kindergarten through postsecondary education, measure student transitions between grade levels and schools, and transfer student information to other school systems and states. A U.S. Department of Education report (2008b) states, "High-quality data is the underpinning for robust accountability systems at the state level and for differentiated instruction inside the classroom. Longitudinal data systems, by following students across grades and schools, help make it possible to

Instant Results: Data-Driven Decision Making

Data-driven decision making is an essential element as educators try to assess student achievement and craft lessons to meet individual learners' needs. Virginia has developed the Educational Information Management System (EIMS) to address these issues. This Web-based system collects required data and stores assessment results to inform decision making based on accurate and timely data. While the information is entered only once, the data can be used in multiple ways. For instance, educators can disaggregate and track data about at-risk students over their entire school careers. Classroom teachers can pull up a test, drill down to see which students struggled with certain items, and then formulate remediation for individual students; they also can examine students' strengths and weaknesses longitudinally over several years to determine possible curricular weakness. The EIMS provides instant data to inform instructional decisions and defines instructional gaps by explaining *how*, not just *what*, students learn.

determine which programs are working. These same data systems also are needed for more ambitious reforms, such as pay for performance. At a minimum, such tools as online assessments help to identify which students need extra assistance. They also save teachers' time, and provide them with information that can be acted on immediately versus waiting for the next school year" (p. 6).

The first step for teachers is to recognize how students perform and determine actions that can be taken to make necessary changes. The use of technology to analyze data can be invaluable in assessing student achievement.

Tools can help gather, organize, analyze, and report on schoolwide student achievement. The *No Child Left Behind Act of 2001* (NCLB) has made schools more responsible for reporting on student academic progress. Neil Mercurius (2005) states, "As a result of NCLB, the teaching community is establishing data repositories to analyze information to improve teaching and learning within the school environment" (p. 33). Schools rely increasingly on technology to help establish and maintain student records. Selecting the appropriate tool will minimize and improve the reliability of reporting on student outcomes and achievement (USDOE & OET, 2004).

As Thomas & Knezek (2002) observe, data obtained from assessment should "ensure that the vision for technology use maintains the appropriate direction" (p. 20). It is equally important to assess teaching and student outcomes. Through careful evaluation of the technology, schools can easily assess if tools are being used effectively to meet goals and objectives.

A second level of assessment becomes more localized as technology provides teachers with access to student information. This access allows educators to monitor individual student and whole-classroom progress. As teachers become better equipped with richer data on individual students, they can individualize instruction and differentiate for student needs (Robertson, 2005).

Some technology tools combine several elements of student data. For example, tools can "gather and synthesize diagnostic information about everything [students] do" (Robertson, 2005, p. 31). The teacher can use this data to guide further planning and quickly recognize student needs. In other instances, tools can suggest instructional resources based on the identified needs of the student (Brown & Lemke, 2007). This type of output can assist teachers in generating more individualized instruction to meet student needs. The ease and timeliness of educational reporting through technology "enables teachers to adjust instructional practices to meet varying student needs" (Brown & Lemke, 2007, p. 4).

A third level of assessment is sustainability of outcomes. A goal of educational reporting and data collection is to make informed decisions about future school efforts, including changes in policies and instructional practices or the selection of tools and resources (Thomas & Knezek, 2002). The focus on standardized test scores forces schools to look for additional information to guide these decisions and "sustain student achievement over the long term" (Robertson, 2005, p. 31). When used properly, technology provides schools with extensive resources and a faster way to gather additional data, keep track of student achievement, and connect decisions with achievement levels. Thomas and Knezek (2002) state, "Changes made over time due to technology innovation should exemplify informed decision-making" (p. 20). When data are collected and analyzed appropriately, decisions regarding teaching and learning strategies will be well-informed, reliable, and valid, thus strengthening educational practices and increasing student achievement.

Personalized Learning

Assessment systems must identify what works for each individual student via *personalized learning*. Technology allows educators to ascertain instant detailed assessment information about each student and adapt their teaching accordingly. It also is important to track each point of a student's decision making; otherwise, assessments provide little more than old-fashioned grading of checkmarks and X's for right and wrong.

Using technology for assessment also can address different learning styles and the specific needs of individual special needs students. For instance, some students might find it easier to use graphic elements rather than text for a test. Technology that supports both methods allows teachers to focus on the learning goals for a particular assessment rather than compensating for the barriers.

Technology-based tools in the classroom can lead to an increase in collaborative projects. Sophisticated evaluation tools built into some of these collaborative endeavors help teachers evaluate the performance not only of the group but also of each individual contributor, highlighting particular strengths and challenges. Such evaluation tools encourage the inclusion of powerful group experiences while meeting the necessity of providing individual evaluations.

Intelligent Assessment

Mary Axelson, Tammy McGraw, and Sheila McEntee (2003) write, "New technologies are making it possible as never before to gather, store, and analyze data on student achievement, and thus to develop assessments that capture rich, multidimensional information" (p. 3). Intelligent assessment systems, enabled by these technologies, reflect the depth and complexity of students' understanding and, to the extent possible, serve both formative and summative needs. At the core of these systems are cognitively-based teaching and assessment methods such as those put forward in *Knowing What Students Know: The Science and Design of Educational Assessment* (Pellegrino, Chudowsky, & Glaser, 2001). Technology can document what students know, indicate how they acquire knowledge, and teach them how to learn. It also can demonstrate that students ultimately are personally responsible for their own learning.

Intelligent tutors use current research in cognitive science to create tools that respond to each student based on his or her demonstrated knowledge and skill level, helping them immediately to analyze and remediate their own errors. Other tools use scientific analyses of expert approaches to problem solving to help students learn how to improve their thinking skills.

Over the next six years, assessments will increasingly combine all of these elements to adapt to the needs of each student. *Intelligent assessments* personalize the testing experience, maximize students' strengths, and help them address weaknesses. Intelligent assessments can respond to current needs and adapt to changes in technology, economic conditions, and curricula. Teachers and students will continue to learn how to use the data provided by such assessments more effectively. At the same time, schools need to be aware of the challenges these new technologies pose to student privacy and system security.

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Conclusion

The five components of this technology plan conceptually stand alone on the framework graph. In reality, however, their planning and execution must be seamless. When technology is used effectively, it is difficult to discern the differences among environment, engagement, application, tools, and results. As such, each school and division must enact education plans that implement all five components collectively.

The demands of the 21st century compel schools to incorporate technology in ways that open worlds that were never before possible. Technology "can help the nation's schools deliver a world class education that will improve student achievement and develop 21st century skills" (CEO Forum, 2001, p. 5).

The success of students and schools is not completely dependent on technology alone. Several factors are important to fostering a technology-rich environment:

1. **Create a learning environment that supports 21st century learning and that opens limitless possibilities for students.**

2. **Engage students in ways that personalize learning and encourage collaboration.**

3. **Ensure proper application of technology to encourage acquisition of content and engage students in real-life learning situations.**

4. **Understand the capabilities of the technology tools and identify authentic tools that prepare students for the 21st century world.**

5. **Use technology to gauge results and make decisions about further planning and purchasing.**

As educators think more deeply about these factors, schools will begin to realize the potential technology offers for teaching and learning.

Perhaps the most important message in creating a successful learning environment through technology is the context, needs, and characteristics of the school. There is no perfect solution for integrating technology into schools; rather, technology should be custom-designed to meet the needs of each individual classroom (Koehler & Mishra, 2008). This customization should empower schools to recognize the true potential of technology for each student. Flexibility allows technology to be manipulated and adapted to meet the varying needs of teachers and students. It is important for schools to recognize and outline clear teaching goals and objectives and then plan to incorporate technology into those objectives.

The North Central Regional Educational Laboratory (NCREL) surveyed various schools to determine their individual contributions to academic success. The study revealed that high-performing schools use technology appropriately to meet their goals and that "educational technology . . . can help create and maintain" a successful learning environment (NCREL, 2004, p. 5). In addition, teachers in the participating schools "use technology as a tool . . . but do not regard technology as sufficient in itself to ensure academic success" (p. 5).

The clear message here is that while technology can bring new and innovative opportunities to the classroom, the more important consideration is its value and applicability to meeting each school's goals and objectives. This occurs through understanding these goals and objectives, learning about the capabilities of the technology, and carefully planning for technology use and application in the educational environment. By understanding these factors thoroughly, schools will use time and resources efficiently and effectively while creating opportunities for student academic success.

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APPENDIX A

Essential Elements of ICT Literacy

What Students Need to Know about ICT Literacy

Choose appropriate technologies to complete particular tasks and learn new technologies when needed:

- Become familiar with the strengths and weaknesses of various technologies for supporting different tasks (e.g., writing, research, presentations, creating artwork).
- Have a working knowledge of locally available technologies.
- When completing educational tasks, consider which technologies may help and use those that are available.
- Incorporate appropriate new technologies as they become available.

Use technologies to develop strong thinking skills and extend capabilities:

- Use built-in assessments, or self-assessment tools, to increase skills and understanding of their learning processes (metacognition).
- Effectively and rapidly evaluate information to make decisions.
- Approach authentic tasks with flexibility and persistence; adapt technologies to make them useful.
- Use technology to seek out diverse perspectives and develop multiple solutions.

Use technologies ethically and safely:

- Comply with current copyright laws.
- Use borrowed technology with respect and care.
- Never use technology to bully, coerce, or harass any other person; be accountable for conduct when using technology.
- Be aware of safety issues related to all technologies, but specifically communication technologies.
- Follow the division's current guidelines for ethics and safety (identified in each division's acceptable use policy).

Understand the nature of information in a global world and the characteristics of various media:

- Become informed about other cultures so all global communication can be made respectfully.
- Recognize when information is needed and determine where to locate the appropriate information.
- Evaluate information based on accuracy, relevance to a task or question, and appropriateness.

- Be aware of the strengths and weaknesses of various types of media and how media (including one's own creations) can influence people.
- Be able to deconstruct and construct media messages.

Use technologies to facilitate collaboration and teamwork:

- Show respect and care for others at all times, even when technology makes them seem *not real.*
- Actively pursue collaborations with both local community members and people in other communities.
- Be flexible in taking different roles (e.g., leader/follower, orator/listener) on teams as the situations require.

What Parents, Grandparents, and Caregivers Need to Know about ICT Literacy

Technology is just one tool for learning:

- Children should not learn everything through technology; there must be time for real-life play, activity, and interaction.
- Time spent with technology should be limited in a child's earliest years, with increasing use allowed as the child matures.
- Participate in technology interactions with young children, allowing more and more autonomy as the child matures and learns norms of behavior.

Technology, by itself, is neutral but can be used for both good and bad things:

- Provide good role models for acceptable behavior and respect for others.
- Learn how to identify safety or ethical problems encountered by children and have a plan for handling these issues before they arise.
- The content of some media is objectionable. Establish rules about what is acceptable. Ratings systems are not reliable indicators.
- Be aware of state and federal laws governing technology and its misuse and communicate problems with school personnel.

Children may be more conversant with technology than their parents, but parents have more practical experience in real-life situations:

- Help children understand that all media messages are constructed and promote deconstruction and construction of media messages.

- Help children learn how to evaluate the motives of various media messages.

- Be aware of the strengths and weaknesses of various media and point these out to children as situations arise.

Good thinking skills enable students to use technology as a powerful learning tool:

- Help students learn how to think critically and creatively.
- Support student collaboration and teamwork.
- Encourage persistence and flexibility in problem-solving tasks.

What Teachers, Instructional Technology Resource Teachers, and Library Media Specialists Need to Know about ICT Literacy

Technology is best used to support curricular goals:

- Make students aware about which types of technologies are available for their use in school and which of their own technologies may be used for schoolwork.
- Engage in professional development to learn how to use available technologies in their own instructional and day-to-day activities.
- Assign authentic tasks that use authentic technology to prepare students for working effectively and living responsibly in the 21st century.

Responsible use of technology must be taught and emphasized during regular school work:

- Be thoroughly familiar with the division's acceptable use policy and ensure students are also.
- Teach technology ethics and safety continuously, both in school and in other areas of students' lives.
- Be good role models for acceptable behavior.
- Learn how to identify ethical or safety errors and know the procedures for addressing these situations before they arise.

Use technologies to develop strong thinking skills and extend capabilities:

- Model critical-thinking and evaluation skills for students.
- Use built-in assessments, or self-assessment tools, to monitor one's own thinking strategies and to increase skills.
- Provide opportunities for students to evaluate information effectively and rapidly in order to make decisions.
- Encourage students to approach authentic tasks with flexibility and persistence.

- Provide a balance between direct instruction and authentic learning experiences.

Provide opportunities for students to experience both the nature of information in a global world and the characteristics of various media:

- Seek opportunities for students to work as teams and collaborate with others from their community and around the world.
- Ensure students are informed about other cultures so communication technology exchanges can be made respectfully with people around the globe.
- Help students discern when information is needed for a task and how to locate the appropriate information that can be evaluated based on accuracy, relevance to a task or question, and appropriateness.
- Be aware of the strengths and weaknesses of various media and make these transparent when involving media resources in instruction.
- Help students understand that all media messages are constructed and teach them to deconstruct and construct media messages effectively.

Technology enables a variety of measures that can be used to support both formative and summative ends:

- Ongoing formative assessments both support and are supported by the use of educational technology.
- Technology can help provide students with useful and immediate feedback to improve their performance.
- Remain up-to-date on new methods of assessment that support the evaluation of complex learning made possible through technology.

What School Administrators Need to Know about ICT Literacy

Technology, as an educational tool, provides opportunities for learning beyond current capabilities:

- Learning skills that use authentic work technologies help keep students motivated and prepare them for lives after school.
- Technology provides an opportunity for students to learn and practice strong thinking and teamwork skills.
- Using technology, students can learn individualized topics in new ways and in unique settings.
- Because technology can provide opportunities for real change in the way students learn, school leaders should allow teachers the flexibility to try new tools and methods.

- When new technologies are deemed useful, barriers to adoption need to be addressed.

Technology enables a variety of measures that can support both formative and summative ends:

- Ongoing, formative assessments both support and are supported by educational technology.
- Technology can help provide students with useful and immediate feedback to improve their performance.
- Stay up-to-date on new methods of assessment that support the evaluation of complex learning made possible through technology.
- Learn how to evaluate and support teachers' uses of technology as effective learning tools.

Leaders provide inspiration and support for teachers and students who use technology for learning:

- School leaders should be good role models for acceptable and safe behavior.
- Reaching out with information and guidance can help parents and other community members understand and support educational uses of technology.
- Administrators must engage in professional development to enable them to be effective users of technology.
- Be aware of current legal and ethical implications of technologies in education and determine procedures to deal with situations before they arise.
- Develop technology plans by encouraging a strong vision among all stakeholders and practical, innovative methods for implementing the vision.

Budgets that provide ongoing support for technology (e.g., infrastructure, personnel, training) are imperative:

- Be aware of the practical implications of existing and new technologies and hire people who can provide good guidance.
- Develop professional development plans that focus on the ICT skills that students need.
- Provide support and incentives to teachers who take risks with new approaches.

What Superintendents and School Boards Need to Know about ICT Literacy

Technology is a tool that supports learning in new ways:

- New technologies, with new capabilities, must be evaluated for their usefulness to a division's educational goals.

- Because technology can provide opportunities for real change in the way students learn, policies should allow flexibility for trying new tools and methods.

When new technologies are deemed useful, barriers to adoption need to be addressed.

Leaders provide inspiration and support for teachers and students who use technology for learning:

- Be good role models for acceptable behavior.
- Reaching out with information and guidance can help parents and other community members understand and support educational uses of technology.
- Be aware of current legal and ethical implications of technologies in education.

Schools are one place where students have equitable access to both technology and the learning of skills that enable them to use technology effectively:

- Technology-rich environments provide support for students with varying needs.
- Budgets that provide ongoing support for technology (e.g., infrastructure, personnel, training) are imperative.
- Encourage schools to use diverse means of evaluation so that 21st century skills may be appropriately measured just as content knowledge is measured.

APPENDIX B

Status of Technology Use in Virginia Schools

Status of Technology Use in Virginia Schools

In spring 2009, the Virginia Department of Education (2009) conducted a survey of all public school divisions in the state regarding educational technology. Nearly 1,244 public schools and 97 divisions responded. The respondents consisted of building administrators or other key building personnel involved with integrating technology for instructional purposes and division technology directors responsible for designing, developing, and implementing efforts to integrate technology into instruction.

Technology in Virginia School Buildings

The technologies students use most commonly include the Internet, desktop computers, Internet search tools, word-processing software, and printers; the least used are statistical-analysis software, videoconferencing tools, Web-page-creation software, management and organization software, and wikis/blogs. In general, a high percentage of students do not have access to personal digital devices, Web-conferencing and videoconferencing tools, e-mail for communications, or wikis/blogs stored on an intranet or the Internet.

Students most frequently use technology to practice or review topics in various subjects, prepare for standardized tests, or extend learning with enrichment activities. They are far less likely to engage in formal distance learning via the Internet or other interactive media; use modeling and simulations to explore complex systems and issues; communicate electronically about academic content with experts, peers, or others; create products for real-world audiences; or solve real-world problems.

Among teachers or administrators, the most widely used technologies include e-mail, the Internet and Internet search tools, a desktop or laptop computer, printers and data projectors, the school division's intranet, and presentation software; the least used are videoconferencing and Web-conferencing tools, multimedia editing or authoring tools, statistical-analysis software, and wikis/blogs stored on the Internet or an intranet.

The survey also addressed technology tools that foster collaboration. More than half the schools do not have videoconferencing equipment; just less than half do not use a Web-conferencing tool. The most commonly available videoconferencing tool is a desktop computer equipped with a camera, speakers, and a microphone.

In terms of technology support, the majority of respondents named the following as the top services provided by library media centers: digital reference/virtual reference services; licensed databases; video content; audio, digital-imaging, or video-production equipment; and instructional television. A vast majority of the respondents believe that their school's technology is reliable, that the technical support is adequate, and that teachers have adequate support to help them integrate technology into the classroom.

With regard to hardware and connectivity, an average of 253 computers per school are available to students; one-third of these are laptops. On average, each school has two handheld computers with Internet access. About three-fourths of the schools use fiber-optic connections to access the Internet. Most

schools have a network connection speed greater than 10 Mbps and use one of the major Internet service providers (e.g., Cox, Verizon, Sprint). Most schools provide wireless access to the majority of instructional areas and other public areas in the building; few provide open wireless access outside the building for the general public. Most respondents consider the school's bandwidth to be at least *usually sufficient* for instructional needs.

Technology in Virginia School Divisions

More than two-thirds of the reporting school divisions noted that their students are computer literate. Nearly all teachers are technologically literate based upon the Technology Standards for Instructional Personnel. Observation and performance-based assessments are the most commonly used methods for assessing technology literacy among students and teachers; although, portfolios increasingly are being used to assess teachers. Just more than one percent of the surveyed teachers are NETS*T certified; about 8.5 percent of the instructional technology resource teachers (ITRT) in the responding divisions are NETS*T certified.

Among division employees, ITRT receive the largest amount of professional development specific to technology (approximately 36.5 hours per school year); teachers are the next highest group with about 15 hours per school year. The most popular technology trainings include multimedia digital content (e.g., digital audio or video) for instruction, Internet resources and communication tools for instruction (e.g., accessing education materials, online discussion forums, virtual field trips), content-specific software tools for instruction (e.g., graphic organizers, interactive mathematics programs, graphing tools), and computers (e.g., word processing, creating spreadsheets, creating Web pages) to enhance student learning The most common types of technology professional development are traditional workshops and conference sessions that last less than three hours; however, 90 percent of the divisions deliver portions of professional development online or through other Web-based resources; 76 percent use one-on-one mentoring.

For teachers and administrators, the most common collaboration tools are e-mail, Web conferencing, and blogs; instant messaging and social networking Web sites are the least used. Students most frequently use blogs or wikis as collaboration tools; they use instant messaging and social networking Web sites the least. In terms of productivity tools, teachers and administrators most commonly use client-server tools (e.g., Mircosoft Office, iWork) and Web-based tools, such as Google Docs. Moodle is the most frequently used course-management tool.

With regard to hardware and policies, 28 percent of the reporting divisions use computers more than four years old; a significant number (33 percent), however, use computers that are less than two years old. A majority have archiving and disaster-recovery plans for electronic records. Of the responding divisions, most have written policies either restricting use or specifying acceptable use by students for MP3 players/iPods, cell phones, e-mail, and wikis/blogs. Fewer address social networking sites directly.

APPENDIX C

Division Plan Alignment
2009-15

Division Plan Alignment • 2009-15

The state's technology plan provides a framework for new division technology plans, suggesting potential courses of action for local strategies. Each focus area (identified by the descriptors in each ring) is a factor that encourages effective technology use. The four key educational components that cross through the focus areas are where technology affects the educational process. The "Goals, Objectives, Strategies, and Evaluation Strategies" move the education system toward more efficacious technology use to support the end goals of teaching and learning.

Each division plan should clearly illustrate the **process** that was followed in developing the plan and the particular **actions** the division intends to take regarding educational technology (e.g., goals, objectives, strategies). The statewide framework serves as a guideline for how division technology planning committees should examine educational technology and develop their plans. It can help them organize their research and the factors that should be considered, including *prompts* for specific facets. The framework demonstrates how all the various focus areas interrelate with one another and with the school system as a whole.

Each division plan must include the following:

I. Cover Page (identify division, effective dates of plan, URL)
II. Table of Contents
III. Executive Summary
IV. Process
    A. Summary of connections to the division's mission, vision, etc.
    B. Summary of work of the planning committee and its benchmarks
    C. Summary of the evaluation process and planned update cycle
    D. Conclusions from Needs Assessment
V. Actions (goals, objectives, strategies, and evaluation strategies)
    A. State goals and objectives with local strategies and measures
    B. Any additional local goals, objectives, strategies, and measures tied to division mission, vision, etc.
VI. Appendix 1: Timetable and Budget for goals, objectives, strategies, and measures (at a minimum, Appendix 1 must be updated after three years, even if the plan covers six years)
VII. Appendix 2: Division AUP (with most recent date it was amended): As required by law, it must include all elements.
VIII. Appendix 3: Summary of Internet safety program for 2008-10 (including process for adjusting program based on evaluation)

Alignment Checklist

Each division must complete and submit this checklist with its plan for the Virginia Department of Education to review.

Planning Process

1. Planning committee group includes all stakeholders (including parents and other elements of community).	
Evidence: List of planners includes wide variety of stakeholders and/or other ways of receiving input.	Note page numbers:
2. Planning committee collaborates regularly.	
Evidence: Dates of planning meetings (face-to-face or electronic) and benchmarks are included in the plan or posted on division Web site.	Note page numbers or URL:
3. Division's mission and vision—and its comprehensive plan's goals and objectives—have been reviewed to inform priorities in relation to its technology plan's goals, objectives, and strategies.	
Evidence: Introduction to plan references specific divisionwide priorities.	Note page numbers:
4. Needs assessment has been conducted.	
Evidence: The plan includes a summary of the needs assessment findings (no need to include the complete findings). The needs assessment must be done before or during the planning process and within the last year. The needs assessment must include staffing, infrastructure, training (including pedagogical approaches), and tools. Resources (i.e., budget, partnerships, and other supporting mechanisms) should be identified to help realistically frame the plan's goals, objectives, and strategies.	Note page numbers:
5. Evaluation is planned as a yearly process.	
Evidence: The evaluation must also include a process by which results of the evaluation are incorporated into the plan over time.	Note page numbers:

Actions

1. State goals and objectives are included as part of the division plan; planning committee develops local strategies.	
Evidence: List of goals and objectives, along with strategies and measures, meets this requirement.	Note page numbers:

2. Division may include other goals and objectives as determined by planning committee, but these must be tied to divisionwide priorities.	
Evidence: List of goals and objectives, along with strategies and measures, meets this option.	Note page numbers (or N/A):

3. Plan includes a reasonable timetable for implementation as well as a reasonable budget.	
Evidence: Timetable and budget are included.	Note page numbers:

4. Plan is available on the division's Web site.	
Evidence: URL is provided on cover sheet of plan.	

5. The evaluation of the plan looks at both the "big picture" and at the specifics. The end goal is not to use more technology but to use technology more effectively to meet educational goals.	
Evidence: The evaluation of the effectiveness of the plan focuses on this question: "Did we help meet statewide and divisionwide priorities as stated in our plan?" Each strategy should have at least one defined measure as well.	Note page numbers:

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Board of Education Agenda Item

Item: M. **Date:** October 22, 2009

Topic: First Review of the Board of Education's *2009 Annual Report on the Condition and Needs of Public Schools in Virginia*

Presenter: Dr. Margaret N. Roberts, Executive Assistant to the Board of Education

Telephone: 804/ 225-2924 **E-mail:** Margaret.Roberts@doe.virginia.gov

Origin:

____ Topic presented for information only (no board action required)

_X__ Board review required by
- _X_ State or federal law or regulation
- ___ Board of Education regulation
- ___ Other:

___ Action requested at this meeting

_X__ Action requested at future meeting: November 17, 2009

Previous Review/Action:

_X_ No previous board review/action
___ Previous review/action:
date:
action:

Background Information: The Board of Education has submitted an annual report each year since 1971, when the requirement was initially adopted by the General Assembly. Section 22.1-18 of the *Code of Virginia* sets forth the requirement that the Board of Education shall submit an annual report on the condition and needs of the public schools in Virginia. This section of the *Code* reads as follows:

> **§ 22.1-18. Report on education and standards of quality for school divisions; when submitted and effective.**
> By November 15 of each year, the Board of Education shall submit to the Governor and the General Assembly a report on the condition and needs of public education in the Commonwealth and shall identify any school divisions and the specific schools therein which have failed to establish and maintain schools meeting the existing prescribed standards of quality. Such standards of quality shall be subject to revision

> only by the General Assembly, pursuant to Article VIII, Section 2 of the Constitution of Virginia. Such report shall include a complete listing of the current standards of quality for the Commonwealth's public schools, together with a justification for each particular standard, how long each such standard has been in its current form, and whether the Board recommends any change or addition to the standards of quality.

The *Code* requires that the annual report contain the following information: a report on the condition and needs of the public schools as determined by the Board of Education; a listing of the school divisions and the specific schools that report noncompliance with any part of the Standards of Quality (SOQ); the full text of the current SOQ; a justification for amendments; the effective date of the current SOQ; and a listing of any amendments, if any, to the SOQ being prescribed by the Board of Education.

Summary of Major Elements: An initial draft of the *2009 Annual Report on the Condition and Needs of Public Schools in Virginia* is attached. At the October 22nd meeting, the Board of Education is requested to review the draft and make any necessary changes, additions, or deletions, all of which will be incorporated prior to the final review and adoption of the report.

The contents of the report include the following major headings:

- Summary of the Academic Progress of Virginia's Students
- Critical Areas of Need for the Public Schools in Virginia
- The Board of Education's Plan of Action
- The Board's Performance Measures: Addressing the Needs of Public Schools
- Compliance with the Requirements of the Standards of Quality
- Compliance with the Standards of Accreditation
- Review of the Standards of Quality

The report also contains appendices directly addressing the information specified in § 22.1-18 of the *Code of Virginia*, as follows:

- Virginia Assessment Program Results: 2005-2009
- Demographics of Virginia's Public Schools
- List of School Divisions Reporting Full Compliance with the SOQ: 2008-2009
- School Divisions Reporting Noncompliance with SOQ: 2008-2009

- Divisions with All Schools Fully Accredited, Schools Granted Conditional Accreditation, Schools Rated Accredited with Warning, and Schools Rated Accreditation Denied: 2008- 2009
- Standards of Quality: Board of Education Recommendations to the 2010 Session of the Virginia General Assembly

Some data elements are not yet incorporated into the draft text (e.g., explanation of the Board of Education's recommendations regarding the Standards of Quality). All data will undergo final verifications and will be added or adjusted prior to the final review of the text at the Board of Education meeting on November 17, 2009. Also, a description and explanation of the Board's final actions regarding the Standards of Quality will be added.

Please note that the *2009 Annual Report on the Condition and Needs of Public Schools in Virginia* will be delivered to the Governor and members of the General Assembly slightly later than November 15 (the due date specified in § 22.1-18 of the *Code of Virginia*).

Superintendent's Recommendation: The Superintendent of Public Instruction recommends that the Board of Education receive the draft report for first review and give staff suggestions for additions and changes to be incorporated into the report prior to the final review on November 17, 2009.

Impact on Resources: Staff at the Department of Education prepared the attached draft; therefore, there is an administrative impact related to preparing the text of the report and the tables contained therein. In addition, there is a minimal administrative impact for preparing, photocopying, and mailing the report to the intended recipients. The fiscal impact of distributing the report is minimal because Legislative Services guidelines for submitting reports to the legislature require that the reports be submitted online rather than in hard copy.

Timetable for Further Review/Action: Suggested changes and additional data will be incorporated into the report, and the updated document will be presented to the Board of Education for final review and adoption at the meeting on November 17, 2009. Following the Board's final adoption, the report will be transmitted to the Governor and the General Assembly as required by the *Code of Virginia*. It will also be made available to the public on the Board of Education's Web site.

DRAFT: For Review October 22

2009
ANNUAL REPORT ON THE CONDITION AND NEEDS OF PUBLIC SCHOOLS IN VIRGINIA

PRESENTED TO
THE GOVERNOR AND
THE GENERAL ASSEMBLY

DRAFT

(DATE)
VIRGINIA BOARD OF EDUCATION

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COMMONWEALTH OF VIRGINIA
BOARD OF EDUCATION
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(date)

The Honorable Timothy M. Kaine, Governor
Members of the Virginia General Assembly
Commonwealth of Virginia
Richmond, Virginia 23219

Dear Governor Kaine and Members of the Virginia General Assembly:

On behalf of the Board of Education, I am pleased to transmit the *2009 Annual Report on the Condition and Needs of Public Schools in Virginia*, submitted pursuant to § 22.1-18 of the *Code of Virginia*. The report contains information on Virginia's public schools, including an analysis of student academic performance and a report on the local divisions' compliance with the requirements of the Standards of Quality and the Standards of Accreditation.

The report contains compelling evidence that our schools and our students are achieving at higher levels. The report also points to evidence that persistent challenges remain to be tackled. The progress shown by our public schools is the result of ongoing collaboration, dedication, workable strategies, and wise use of resources, both human and financial. It is the result of the hard work of students, teachers, administrators, support staff, parents, and supporters throughout the Commonwealth.

We see a challenging year ahead as we face the economic headwinds that have developed in recent months; however, the Board of Education remains focused on the fundamentals of improving instruction for all students. Working together with the Governor, members of the General Assembly, school and community leaders, parents, and private partners, we can improve public education for all of Virginia's young people.

The Board of Education is grateful for the support the Governor and General Assembly continue to give to Virginia's school improvement efforts. As we look to the future, the members of the Board of Education pledge to remain focused on providing the best educational opportunities and the brightest future for the young people enrolled in Virginia's public schools.

Sincerely,

Mark E. Emblidge, Ph.D.
President, Board of Education

Statutory Requirement for the Annual Report

The *Code of Virginia*, § 22.1-18, states:

> By November 15 of each year, the Board of Education shall submit to the Governor and the General Assembly a report on the condition and needs of public education in the Commonwealth and shall identify any school divisions and the specific schools therein which have failed to establish and maintain schools meeting the existing prescribed standards of quality. Such standards of quality shall be subject to revision only by the General Assembly, pursuant to Article VIII, Section 2 of the Constitution of Virginia. Such report shall include a complete listing of the current standards of quality for the Commonwealth's public schools, together with a justification for each particular standard, how long each such standard has been in its current form, and whether the Board recommends any change or addition to the standards of quality.

For Additional Copies

Additional copies of the report are available by contacting Dr. Margaret Roberts, executive assistant to the Board of Education, P.O. Box 2120, Richmond, VA 23218; phone: 804/ 225-2924; Margaret.Roberts@doe.virginia.gov.

The report may be viewed online at: http://www.doe.virginia.gov/boe/reports/index.shtml

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Board of Education
2009 Annual Report on the Condition and Needs of Public Schools in Virginia

EXECUTIVE SUMMARY

Academic Progress of Virginia's Students

Virginia's public schools and our students continue to show overall academic gains and receive national recognition for achievement and innovation. Performance indicators illustrate the progress Virginia's public schools are making in an era when all students must be challenged to reach their highest potential. Highlights of the performance measures contained in this report include the following:

- Ninety-eight percent of Virginia's public schools are fully accredited and meeting state standards for achievement in English, mathematics, history and science based on 2008-2009 assessment results. This is the highest percentage of schools reaching full accreditation since the Commonwealth began accrediting schools based on student achievement ten years ago.

- Virginia fourth-grade and eighth-grade students outperformed their peers nationwide and in the South in mathematics on the 2009 National Assessment of Educational Progress (NAEP). Students in only five states performed at what the National Center for Education Statistics (NCES) considers a statistically higher level on the grade-4 test, and students in only eight states achieved at a higher level on the eighth-grade assessment.

- NAEP results for 2009 also show that African-American fourth graders in only two states—Massachusetts and Texas—achieved statistically higher average scores than those in Virginia. No other states were statistically higher than Virginia in grade 8. In Virginia, the percentage of African-American students in grade 4 meeting or exceeding the NAEP standard is significantly larger today than in 2000.

- Virginia's statewide assessment results also show that Virginia's African-American and Hispanic students continue to narrow achievement gaps with white students in reading and mathematics.

- Virginia ranks third in the nation in the percentage of high school seniors earning a grade of three or better on Advanced Placement (AP) exams. Students who earn scores of three or above are generally considered to be qualified to receive college credit and/or placement into advanced courses.

- Accurate graduation rates for the state, school divisions, and high schools were calculated for the first time in 2008 using the longitudinal student-data system funded by the General Assembly. Eighty-two percent of the students in the class of 2008 graduated on time with a diploma.

- In 2009, Virginia high school students continued to fare better than their national counterparts on the ACT college admissions exam, and our graduates increased their achievement in reading and mathematics on the SAT. African-American and Hispanic Virginia public school graduates again achieved at a higher level on all three SAT subsections than their counterparts nationwide.

- In 2008, 162 Virginia public schools earned the 2009 Governor's Award for Educational Excellence. The award is the highest honor under the Virginia Index of Performance (VIP) incentive program created by the Board of Education to encourage advanced learning and achievement. Last year, 89 schools received the award.

- The percentage of schools making AYP fell as federal benchmarks rose to 81 percent in reading and 79 percent in mathematics. Nonetheless, the percentage of school divisions making AYP increased by six points to 60 percent. Virginia and 71 percent of the public schools met or exceeded all No Child Left Behind (NCLB) objectives based on statewide testing during the 2008-2009 school year as student achievement increased in reading, mathematics and other subjects.

- Industry certifications earned through CTE programs have nearly doubled since 2007. During 2008-2009, 40 percent of CTE completers graduated with an Advanced Studies Diploma.

- *Education Week*, a prominent education journal, ranks Virginia as a national leader in online learning and the use of technology to expand opportunities for students.

Critical Areas of Need for the Public Schools in Virginia

The Board's priorities for action—and the performance measures used to gauge our progress in meeting those priorities—focus on the most critical needs of the public schools. These needs include the following:

- Funding the Standards of Quality (SOQ) in the current fiscal and economic climate.

- Addressing student needs in light of a persistent poverty rate that exists for children and their families, which makes these children more likely to be sick as toddlers, unprepared for kindergarten, fall behind in grade school or drop out of high school, and are less likely to be economically successful as adults.

- Providing programs that address the increase in immigrant students—a large proportion of whom are also poor—who are more likely than others to drop out or leave school without the skills needed in a global marketplace.

- Eliminating gaps in graduation rates and student achievement, although improving, persist among Virginia's African-American and Hispanic students and their white and Asian counterparts.

- Seeking new and efficient ways to use technology to reduce the testing burden on teachers and students, but to do so in a way that will not reduce accountability standards and that can be accomplished with available funding.

- Dealing effectively with the realities of schooling for some children who face difficult personal circumstances such as high poverty, high crime in their neighborhoods, high rates of unhealthy behaviors, poor nutrition, and other circumstances that obstruct their learning at school.

- Continuing the aggressive interventions by the Virginia Department of Education to assist divisions previously identified as low-performing.

- Finding new and effective ways to help colleges and universities and school divisions in the preparation, recruitment, and retention of teachers and other educational personnel.

- Making a concerted effort to develop and promote policies to help divisions recruit and maintain minority teachers and educational personnel.

- Maintaining emphasis on quality programs for at-risk four-year olds across the state in an era of reduced resources.

- Finding and promoting new and effective ways to involve parents in their child's education, a critical need that must be addressed if Virginia is to promote safe and healthy school environments, and eliminate achievement gaps.

Objectives of the Board of Education

The Board of Education's *Comprehensive Plan: 2007-2012* established the following priorities for action. Contained in this report are highlights of the Board of Education's recent actions to met the objectives.

Objective 1: The Board of Education will continue to enhance the quality standards for all public schools in Virginia.

Objective 2: The Board of Education will provide leadership to help schools and school divisions eliminate the achievement gap between groups of students and increase the academic success of all students.

Objective 3: The Board of Education will support accountability for all schools, focusing on assisting chronically low-performing schools and school divisions while recognizing all schools and school divisions as they move towards excellence.

Objective 4: The Board of Education will work cooperatively with partners to help ensure that all young children are ready to enter kindergarten with the skills they need for success.

Objective 5: The Board of Education will establish policies that support the attainment of literacy skills of all students, kindergarten through grade 12.

Objective 6: The Board of Education will establish policies and standards that enhance the preparation, recruitment, and retention of educational personnel, including their meaningful, ongoing professional development.

Objective 7: The Board of Education will provide leadership in implementing the provisions of state and federal laws and regulations.

Objective 8: The Board of Education will provide leadership to help schools and school divisions ensure a safe and secure environment conducive to facilitating the teaching and learning process.

Compliance with the Standards of Quality

(Data to be finalized) _____ divisions reported full compliance with the provisions of the Standards of Quality (SOQ) in the 2008-2009 school year (Appendix C). Appendix D contains a list of school divisions that have reported noncompliance with certain provisions of the SOQ.

Compliance with the Standards of Accreditation

As noted above, 98 percent of Virginia's public schools are fully accredited and meeting state standards for achievement in English, mathematics, history and science based on 2008-2009 assessment results. Schools failing to meet the accreditation requirements are listed in Appendix E.

Review of the Standards of Quality

Between the spring and fall of 2009, the Board reviewed the Standards of Quality and solicited public comment. The Board began this important work through its Committee on the Standards of Quality. The committee held several forums with statewide professional organizations to hear comments and suggestions from key constituencies in the field. Additionally, the Department of

Education, through the Request for Proposal process, commissioned a study of SOQ funding, which was completed by an outside vendor. Through this statewide, interactive process, the Board of Education, on October 22, 2009, adopted recommendations that will be considered by the 2010 General Assembly. The details of the Board's recommendations are contained in the body of this report and are shown in Appendix F.

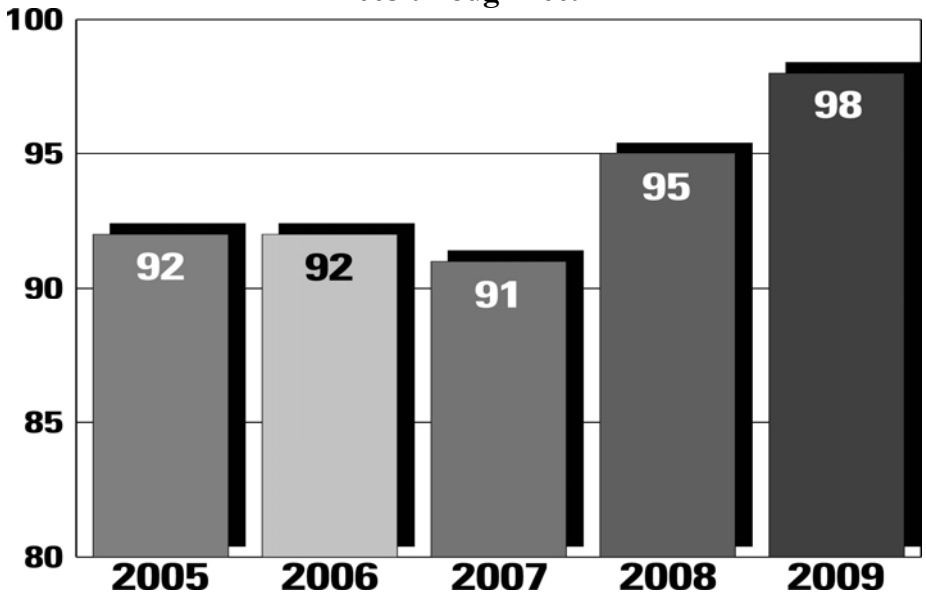
2009 Annual Report on the Condition and Needs of Public Schools in Virginia

Academic Progress of Virginia's Students

Virginia's public schools and our students continue to show overall academic gains and receive national recognition for achievement and innovation. The high expectations of the Standards of Learning, effective accountability, and a statewide system of support for public education are creating new opportunities for advanced learning at every grade level. The following performance indicators illustrate the progress Virginia's public schools are making in an era when all students must be challenged to reach their highest potential.

<u>High Percent of Schools are Fully Accredited</u>

Percent of Schools in Virginia Rated Fully Accredited 2003 through 2009



Ninety-eight percent of Virginia's public schools are fully accredited and meeting state standards for achievement in English, mathematics, history and science based on 2008-2009 assessment results. This is the highest percentage of schools reaching full accreditation since the Commonwealth began accrediting schools based on student achievement ten years ago.

Virginia Students Outperform Peers Across Nation in Reading, Mathematics

Virginia fourth-grade and eighth-grade students outperformed their peers nationwide and in the South in mathematics on the 2009 National Assessment of Educational Progress (NAEP). Students in only five states performed at what the National Center for Education Statistics (NCES) considers a statistically higher level on the grade-4 test, and students in only eight states achieved at a higher level on the eighth-grade assessment.

NAEP results for 2009 also show that African-American fourth graders in only two states—Massachusetts and Texas—achieved statistically higher average scores than those in Virginia. No other states were statistically higher than Virginia in grade 8. In Virginia, the percentage of African-American students in grade 4 meeting or exceeding the NAEP standard is significantly larger today than in 2000.

NAEP results in previous years show that Virginia leads the nation in grade-4 science achievement. Virginia had the highest achieving girls in science on the 2007 NAEP and Virginia's fourth-grade boys came within one point of having the highest average score for males. Virginia students also outperform their peers in writing. On the 2007 NAEP writing test, Virginia students scored significantly higher than students in 20 other states and students in only seven states achieved significantly higher average scores.

Notable Progress in Eliminating Achievement Gaps

While achievement gaps persist, the evidence from Virginia's statewide assessment program shows that gaps are closing. African-American and Hispanic students continue to narrow achievement gaps with white students on state assessments in reading and mathematics. During last three years achievement gaps have narrowed in:

- Mathematics by 4 points for African-American students and 3 points for Hispanic students even though the performance of white students increased by 5 points.

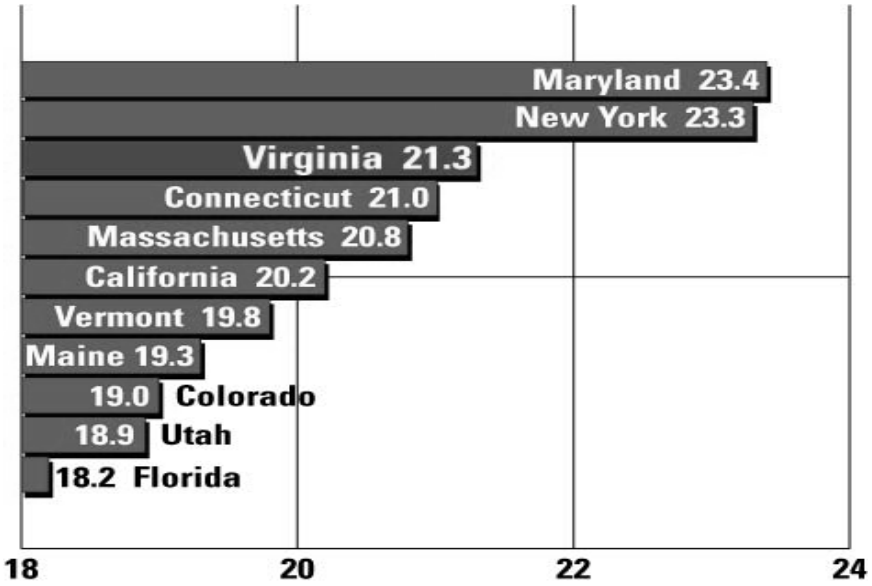
- Reading by 2 points between African-American and white students, despite a 3-point increase for white students; and 10 points between Hispanic and white students.

Virginia Leads the Nation in Online Learning

A prominent education journal ranks Virginia as a national leader in online learning and the use of technology to expand opportunities for students. In ranking Virginia, *Education Week* cited Virginia's low student-to-computer ratios, expanding online assessment program, rigorous technology standards and innovative online learning programs, including Virtual Virginia, which has broadened access to Advanced Placement (AP) and other challenging courses for the state's middle and high school students.

Virginia is Third in the Nation on Advanced Placement (AP) Results

Advanced Placement (AP) Test Results:
Virginia's Ranking Among Selected States
2009



Virginia ranks third in the nation in the percentage of high school seniors earning a grade of three or better on AP exams. In 2008, the number of Virginia public school students who took at least one AP test increased by 8.8 percent. Students who earn scores of 3 or above are generally considered to be qualified to receive college credit and/or placement into advanced courses.

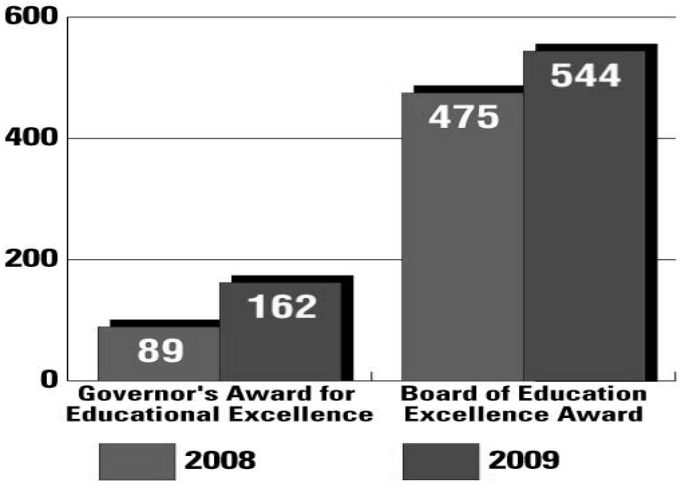
Students Outperform Peers on College Entrance Examination Results

ACT: Virginia high school students continued to fare better than their national counterparts on the ACT college admissions exam. Seventy-four percent of Virginia's students met college-readiness English benchmarks compared with 67 percent nationally. For mathematics, 49 percent of Virginia students met the mark, while 42 percent of students across the country did. For reading, Virginia students were at 59 percent compared to the national number of 53 percent. In science, Virginia had 33 percent reach the benchmark compared with 28 percent nationally.

SAT: Virginia public school graduates increased their achievement in reading and mathematics on the SAT in 2009 and outperformed their peers nationwide on all three subsections of the college-admissions test. African-American and Hispanic Virginia public school graduates again achieved at a higher level on all three SAT subsections than their counterparts nationwide.

Number of High-Performing Schools Increases Significantly

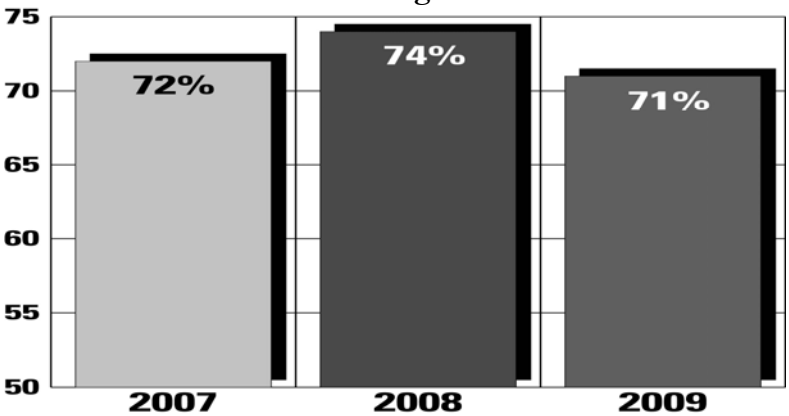
Number of Schools Earning Recognition:
Virginia Index of Performance (VIP)
2008 and 2009



In 2008, 162 Virginia public schools earned the 2009 Governor's Award for Educational Excellence. The award is the highest honor under the Virginia Index of Performance (VIP) incentive program created by the Board of Education to encourage advanced learning and achievement. Last year, 89 schools received the award.

Students Again Meet or Exceed Federal Benchmarks

Percentage of Virginia's Schools Meeting Federal
Adequate Yearly Progress (AYP) Benchmarks
2007 through 2009

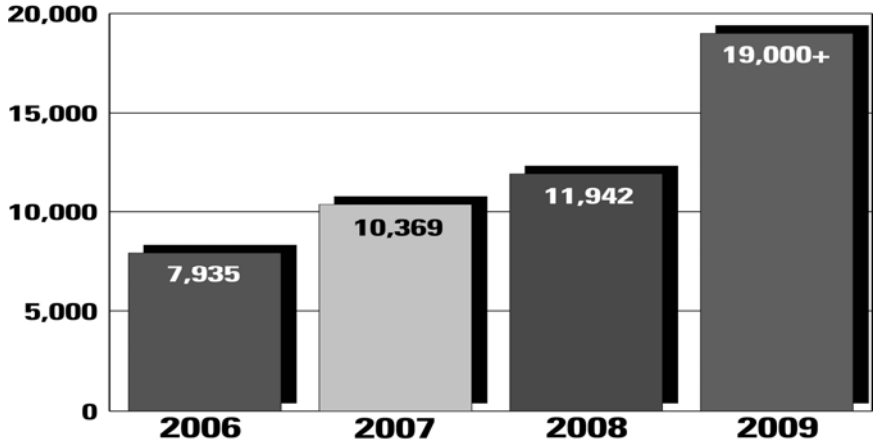


The percentage of schools making AYP fell as federal benchmarks rose to 81 percent in reading and 79 percent in mathematics. Nonetheless, the percentage of school divisions making AYP increased by six points to 60 percent. Virginia and 71 percent of the Commonwealth's public schools met or exceeded all No Child Left Behind (NCLB) objectives based on statewide testing during the 2008-2009 school year as student achievement increased in reading, mathematics and other subjects. It was the second consecutive year and the fourth time in the last five years that Virginia achieved what the federal law describes as "adequate yearly progress," or AYP, toward 100-percent proficiency for all students in reading and mathematics, the two subjects that are the primary focus of the federal law.

Student achievement — especially among minority students — increased overall and in critical areas such as early reading and middle school mathematics. This continued progress (reflected also in the NAEP results shown above) reflects improvements in teaching and learning in formerly low-performing schools and a data-driven, student-by-student approach to raising achievement.

Impressive Growth in Number of Students Earning Industry Certifications

Number of Industry Certifications Earned by Virginia's Public School Students



Industry certifications earned through CTE programs have nearly doubled since 2007. During 2008-2009, 40 percent of CTE completers graduated with an Advanced Studies Diploma.

Critical Areas of Need for the Public Schools in Virginia

The overarching need is to ensure that all of Virginia's young people achieve high standards of excellence, no matter what community they reside in or what challenges they face. The Board of Education's priorities for action acknowledge the challenges of the 21st century—the rapid growth in technology, the changing demographics of our schools, and greater demands for skills for all citizens. Meeting the needs of our public schools calls for more political, financial, legislative, and programmatic will than ever before to ensure the success of all Virginia's students.

The Board's objectives—and the performance measures used to gauge our progress in meeting those objectives—focus on the most critical needs of the public schools. These needs include the following:

- Funding the Standards of Quality (SOQ)
  There can be no doubt that a challenging year is ahead as Virginia's public schools face the economic headwinds that have developed in recent months. In Virginia, Direct Aid to localities for public education is the single largest General Fund expenditure. The current fiscal climate at the state and federal levels challenges the stability of public education, social-services, and other supports for children and families. Resources are limited for students who require extra help, such as gifted students or students with disabilities who need special attention. The challenge requires that all educators remain focused on the fundamentals of making sure every student under our charge is successful and that we remain committed to delivering results.

- Persistent Poverty
  One in ten Virginians lives in poverty, whether native-born or foreign-born. Children living in poverty are more likely to be sick as toddlers, unprepared for kindergarten, fall behind in grade school or drop out of high school, and are less likely to be economically successful as adults.

  Since 2000, the poverty rate among Virginia's school-age children has fallen, but not among children in public school. Poverty distribution is uneven across the state – rural counties and central cities have the highest percent of students eligible for free and reduced lunch. One-third of public school children are eligible for free and reduced-price lunch, up from less than 30 percent in 2000.

- Changing Demographics

  In 1998, Virginia's public schools enrolled fewer than 27,000 Limited English Proficient (LEP) students. A decade later (2008) the number had risen to more than 87,000. This growth is expected to continue for the foreseeable future, thus placing a significant need for resources for the public schools. In 2009, one in ten Virginians is foreign-born.

International immigrants comprise one quarter of Virginia's recent population growth. Many live in homes in which neither parent speaks English. Immigrant students—a large proportion of whom are also poor—are more likely than others to drop out or leave school without the skills needed in a global marketplace.

- Persistent Achievement Gaps
  Gaps in graduation rates exist between Virginia's African-American and Hispanic students and their white and Asian counterparts, and for students who are economically disadvantaged. Although improving, gaps also persist among Virginia's African-American and Hispanic students and their white and Asian counterparts.

- Availability and use of latest technology
  At the state level, Virginia is seeking new and efficient ways to use technology to reduce the testing burden on teachers and students, but to do so in a way that will not reduce accountability standards. The infrastructure for such powerful tools is expensive to develop and maintain. Moreover, technology and connectivity have made changes possible by allowing access by essentially everyone to very large data sets or specialized information at any location and at any time. Students in the future will have grown up with these technological changes and will have experienced a wider variety of learning styles than students in the past. This change in teaching/learning approaches has been underway for some time, but it is accelerating and changing the character of the learning experience for students, and will continue to do so for classroom teachers, many of whom require training in the appropriate and efficient use of the technology.

- Safe and Healthy Environments for Students and Teachers:
  A high priority for the Board is dealing effectively with the realities of schooling for some children who face difficult personal circumstances such as high poverty, high crime in their neighborhoods, high rates of unhealthy behaviors, poor nutrition, and other circumstances that obstruct their learning at school. The Board of Education must help local divisions by providing solid, workable guidelines and policies to assist those who are responsible for the health and safety of students and staff while they are at school, on school grounds, on their way to or from school, and involved in school-sponsored activities. The Board must continue to stress the importance of successful, community-wide partnerships in the development of procedures and policies that most effectively support healthy, safe, orderly and disciplined school environments.

- The Need to Assist Chronically Low-Performing Schools
  Aggressive interventions by the Virginia Department of Education and well-defined partnerships between the Board of Education and local school boards have produced positive results in divisions previously identified as low-performing.

- Preparation, Recruitment, and Retention of Educational Personnel
  In 2008-2009, Virginia's public schools employed almost 101,000 instructional personnel (includes licensed teachers, library-media specialists, guidance counselors, etc), up slightly from the previous school year. In addition, more than 4,100 principals and assistant

principals were employed. Approximately one-fifth of our teaching force and one-fourth of the principals and assistant principals are aged 55 or older. Hence, Virginia has a significant number of teachers and principals at or nearing full retirement age. The number of completers of Virginia's teacher preparation programs is around 3,200 each year, far short of the 5,100 new and beginning teachers hired by Virginia's public schools in 2008-2009. Moreover, Virginia's annual teacher turnover rate is slightly more than nine percent. For principals and assistant principals, the annual turnover rate is higher, at 10 percent.

- Recruiting Minority Teachers
  The gap between the diversity of students in the schools and the ethnic characteristics of the teaching force poses a key question: will teachers reflect the tremendous diversity of the students they will serve? Not without a concerted effort. In Virginia, 13 percent of teachers are African-American and 2 percent are Hispanic, compared with approximately 26 and 9 percent of students, respectively.

- High-Quality Preschool Programs
  The number of school divisions participating in the Virginia Preschool Initiative has grown from 75 in the 2001-2002 school year, to 114 in the 2008-2009 school year. Also, the number of children served has grown from 5,966 in 2001-2002 to 15,657 children in 2008-2009. Despite this growth, the number of at-risk four-year-olds in Virginia continues to be a concern. Without providing high quality preschool to all at-risk four-year-olds, many at-risk five-year-old children will continue to enter kindergarten without adequate preparation to be fully ready to learn.

- Promoting Parental and Family Involvement
  The family and the home are both critical education institutions where children begin learning long before they start school, and where they spend much of their time after they start school. It stands to reason that involving parents in their child's education is conducive to learning. Such involvement is critical if we are to improve the educational achievement of Virginia's students, promote safe and healthy school environments, and eliminate achievement gaps. To do this, schools need to promote and enhance cooperative partnerships in which families are allies in the efforts of teachers and schools.

The Board of Education's Plan of Action

The Board of Education's objectives for our schools directly address the imperative to improve student achievement. The objectives include the following:

- Reaching high quality standards for all schools;
- Eliminating achievement gaps;
- Maintaining public accountability;
- Cooperating with partners to help put preschool programs in place;
- Supporting attainment of literacy skills for all students;
- Ensuring students' access to expert, highly-qualified teachers;

- Implementing provisions of state and federal laws and regulations pertaining to our public schools; and
- Helping schools create and maintain safe and orderly environments for children and their teachers.

The Board of Education has adopted a comprehensive plan of action for the coming years. More details for the plan of action may be found in the Board of Education's *Comprehensive Plan: 2007-2012*, which may be viewed on the Board of Education's Web site at the following address: http://www.doe.virginia.gov/VDOE/VA_Board/comprehensiveplan.pdf. It outlines eight objectives (discussed in more detail below), along with strategies and activities that will provide the framework for the Board of Education's focus for the near future.

The Board's Performance Measures: Addressing the Needs of Virginia's Public Schools

The following objectives were set by the Board to address the complex challenges that impact our schools and our young people.

Objective 1: The Board of Education will continue to enhance the quality standards for all public schools in Virginia.

Within the past two years, the Board of Education revised Virginia's accreditation standards to require high schools to meet an annual benchmark for graduation. The "graduation and completion index" requires schools to meet a minimum benchmark to be fully accredited. The new accountability requirement—and others approved as part of a revision of the Standards of Accreditation—will be phased in, beginning with accreditation ratings for the 2011-2012 school year. Other important changes include the following:

- Requiring schools to develop an Academic and Career Plan for every middle and high school student, beginning with students entering the seventh grade during the 2010-2011 school year.
- Requiring students, beginning with students entering the ninth grade in 2010, to successfully complete a one-credit course in economics and personal finance to earn the Standard, Advanced Studies, Standard Technical or Advanced Technical Diploma.
- Prescribing rigorous requirements for the new Standard Technical Diploma and the new Advanced Technical Diploma.

Objective 2: The Board of Education will provide leadership to help schools and school divisions eliminate the achievement gap between groups of students and increase the academic success of all students.

While progress is encouraging, there is still work to be done to eliminate achievement gaps. In 2008, Virginia's African-American and Hispanic student graduation rates were 12 and 15 percentage points lower than their white counterparts, and 20 or more percentage points below their Asian counterparts.

There is, however, evidence that Virginia's efforts to eliminate achievements gaps are showing results. A new U.S. Department of Education (USED) report recognizes Virginia for narrowing achievement gaps between African-American and white students in reading and mathematics. The report, *Achievement Gaps: How African-American and White Students in Public Schools Perform in Mathematics and Reading on the National Assessment of Education Progress* (NAEP), compares student achievement in 2007 with performance in previous years. In comparing the performance of students nationwide with state-level achievement on the national fourth- and eighth-grade reading tests, the USED National Center for Educational Statistics reports that:

- Virginia is one of only five states with achievement gaps in reading smaller than the nation's in both grades.
- Virginia is one of only three states where the achievement gap in grade-four reading narrowed between 2005 and 2007 because of increased African-American achievement.
- Virginia's achievement gap in grade-four reading is a statistically significant 7 points smaller than the gap nationwide, and in grade-eight, the gap is a statistically significant six points smaller.
- Virginia is one of 13 states where fourth-grade reading achievement is higher for both African-American and white students than in 1992, the first year of NAEP reading tests in grade four.

The report also credits Virginia for narrowing achievement gaps in mathematics:

- Virginia is one of only four states where fourth-grade mathematics scores increased for both African-American and white students between 2005 and 2007.
- Virginia is one of 15 states to narrow the achievement gap in fourth-grade mathematics as a result of African-American students outpacing the gains of white students since 1992, when grade-four NAEP mathematics testing began.
- Virginia is one of 26 states where mathematics scores for both African-American and white eighth graders increased since grade-eight NAEP mathematics testing began in 1990.

Objective 3: The Board of Education will support accountability for all schools, focusing on assisting chronically low-performing schools and school divisions while recognizing all schools and school divisions as they move towards excellence.

The Department of Education promotes student learning and achievement by assisting schools and school divisions in the implementation of effective instructional strategies and best practices. Programs include school-level and division-level academic reviews, school improvement planning, and innovative programs such as the Partnership for Achieving Successful Schools (PASS).

Virginia has fewer chronically low-performing schools, defined as schools that were accredited with warning for three consecutive years. The number of chronically low-performing schools dropped significantly for the 2009-2010 accreditation year.

School accreditation year	Number of chronically low-performing schools
2009-2010	11
2008-2009	33
2007-2008	42
2006-2007	58

Objective 4: The Board of Education will work cooperatively with partners to help ensure that all young children are ready to enter kindergarten with the skills they need for success.

The Board of Education has supported efforts to provide high quality early learning experiences for preschool-age children. Virginia's Office of Early Childhood Development was launched in July 2008. The purpose of the new office is to maximize opportunities for Virginia's children to reach kindergarten healthy and prepared for school success.

This is a unique, interagency effort spanning the Departments of Education and Social Services and will link to the Department of Health, and incorporates existing staff, functions, programs, and funding streams. Through this office, Virginia's early childhood initiatives are coordinated: Smart Beginnings, the Governor's Working Group on Early Childhood Initiatives, Virginia's Star Quality Initiative, the School Readiness Task Force, and others.

In 2008, to facilitate delivery of programs to young children the Board of Education adopted a standard definition of school readiness, which describes the concept of children's readiness for school at kindergarten entry in the context of ready families, schools, and communities. It describes the capabilities of children, their families, schools, and communities that will best promote student success in kindergarten and beyond.

Students who participate in public preschool programs, including the Virginia Preschool Initiative program continue to have fewer needs for extra support in learning how to read when they enter kindergarten compared to the entire kindergarten class. As well, the data suggest that Virginia's collaborative and multi-year effort to increase student preparedness for kindergarten is having an impact. Virginia saw a 3 percentage point drop (see table below) in the percent of kindergarten students who enter school requiring extra support to be on track to learn to read.

	Percent requiring extra support to stay on track to learn to read			
Student group	**Fall 2005**	**Fall 2006**	**Fall 2007**	**Fall 2008**
Attended any type of public preschool the year before kindergarten	13%	13%	11%	12%
Attended VPI programs the year before kindergarten	13%	11%	10%	9%
All kindergarten students participating in pre-literacy screening in kindergarten	18%	17%	17%	14%

Objective 5: The Board of Education will establish policies that support the attainment of literacy skills of all students, kindergarten through grade 12.

The 2009 revision of the Standards of Accreditation incorporates several key elements of Governor Timothy Kaine's "competence to excellence" education agenda enhancing the literacy and academic success of students, including:

- Requiring schools to develop an Academic and Career Plan for every middle and high school student, beginning with students entering the seventh grade during the 2010-2011 school year;
- Prescribing rigorous requirements for the new Standard Technical Diploma and the new Advanced Technical Diploma; and
- Requiring students, beginning with students entering the ninth grade in 2010, to successfully complete a one credit course in economics and personal finance to earn the Standard, Advanced Studies, Standard Technical or Advanced Technical Diploma.

The revised accreditation regulations also delay by one year scheduled increases in rigor that were already in the regulations, including boosting the required pass rate in English for all grades from 70 to 75 percent. Further, the combination of the graduation and completion index for high school accreditation and the existing requirement to pass the high school reading and writing end-of-course assessments to graduate provide powerful policy levers to support all students' literacy skills attainment.

Objective 6: The Board of Education will establish policies and standards that enhance the preparation, recruitment, and retention of educational personnel, including their meaningful, ongoing professional development.

The 2007 General Assembly passed House Joint Resolution 622 requesting the Board of Education to establish and regularly convene a Commonwealth Educational Roundtable to facilitate the implementation and continuation of efforts to improve and sustain quality educational leadership in the Commonwealth's public schools. Subsequently, the membership was designated, including representation from the Board of Education.

To kick-start its work, Virginia received a grant from the Wallace Foundation providing funding to "Advance Virginia's Leadership Agenda." This funding was to strengthen standards and identify indicators for school leaders (assistant principals and principals) and provide guidance to school divisions in recommending principals for the Level II administration and supervision endorsement. The Board of Education adopted these guidelines in November 2008.

On September 21, 2007, the Board of Education's *Licensure Regulations for School Personnel* became effective. These regulations established alternate routes to the administration and supervision endorsement, created Level I and Level II administration and supervision endorsements, and included the school leaders licensure assessment as a requirement for school principals consistent with the *Code of Virginia*.

Objective 7: The Board of Education will provide leadership in implementing the provisions of state and federal laws and regulations.

During the past two years, the Board of Education has been actively engaged in revising its *Regulations Governing Special Education Programs for Children with Disabilities in Virginia*. The revision was necessary to make a number of updates and to bring the state's regulations in line with the recent reauthorization of the federal law and related federal regulations. By ensuring that Virginia's state special education regulations are aligned with federal requirements, the Board ensures that students with disabilities in the Commonwealth have available a free appropriate public education and are afforded the procedural safeguards guaranteed by federal law.

Another important area that has huge impact on local school divisions is the Virginia Department of Education's role in assisting localities to receive and appropriately utilize the funding flowing from the American Reinvestment and Recovery Act (ARRA) of 2009, which provides millions of dollars of support for Virginia's schools. While the Board of Education's role is limited, the technical assistance provided by the department is critical in implementing the provisions of this program.

In using ARRA funds, the state and school divisions must advance core reforms which have long been a key part of our key objectives: implementation of college- and career-ready standards and assessments for all students; establishment of preschool to postsecondary and career longitudinal data systems; improvement in teacher quality—especially for students most at risk of academic failure; and improvement of low-performing schools through effective interventions.

Objective 8: The Board of Education will provide leadership to help schools and school divisions ensure a safe and secure environment conducive to facilitating the teaching and learning process.

To illustrate how the Board of Education and the Department of Education must respond to evolving critical needs and concerns across the state, the Virginia Department of Education provided leadership, guidance, and resources to school division personnel in meeting the challenges posed by the H1N1 influenza pandemic. During 2009, the department initiated and maintained an H1N1 influenza Web site dedicated to providing resources specific to the education community. The *Pandemic Influenza Plan Guidelines for Virginia Public Schools* and the *Pandemic Influenza Planning for Schools: Social Distancing Strategies by Pandemic Phase* guidance documents, developed by the department to assist school division personnel in developing their division specific plans, have been reviewed and made available to school division leadership.

In addition, the department collaborated with Virginia Department of Health and the Virginia Department of Treasury to ensure that school nurses giving H1N1 flu vaccinations as part of school immunization clinics are covered under a medical liability insurance policy. As of October 2009, 123 school divisions have committed to hold school based immunization clinics utilizing either health department personnel or school nurses to administer the vaccinations.

Compliance with the Requirements of the Standards of Quality

Section 22.1-18 of the *Code of Virginia* requires the Board of Education to "identify any school divisions and the specific schools therein which have failed to establish and maintain schools meeting the existing prescribed standards of quality."
(Text to be added here…)

Compliance with the Requirements of the Standards of Accreditation

Ninety-eight percent of Virginia's public schools are fully accredited and meeting state standards for achievement in English, mathematics, history and science based on 2008-2009 assessment results. This is the highest percentage of schools reaching full accreditation since the Commonwealth began accrediting schools based on student achievement ten years ago.

Students in 98 percent, or 1,826, of Virginia's 1,867 schools met or exceeded state objectives on Standards of Learning (SOL) tests and other statewide assessments in the four core academic areas last year. Virginia's public schools have accomplished what many ten years ago thought was impossible. With the sustained support of governors, legislators and policy makers from both parties, teachers and other educators have met the challenge of higher standards and students are achieving at significantly higher levels in nearly every school in the Commonwealth.

The percentage of middle schools achieving full accreditation increased again as the performance of students on rigorous grade-level mathematics tests introduced four years ago continued to improve. Ninety-six percent, or 299, of Virginia's 312 middle schools are now fully accredited compared with 87 percent last year and 69 percent two years ago.

All but a handful of schools are now meeting or exceeding state standards even though the rigor of the Commonwealth's SOL accountability system has increased. The Board of Education will maintain its focus on raising achievement in schools that have yet to earn and maintain full accreditation.

The accreditation ratings are based on the achievement of students on SOL assessments and approved substitute tests in English, mathematics, history and science administered during the summer and fall of 2008 and the spring of 2009, or on overall achievement during the three most recent academic years. The results of tests administered in each subject area are combined to produce overall school passing percentages in English, mathematics, history and science.

In middle schools and high schools, a pass rate of at least 70 percent in all four subject areas is required for full accreditation. In elementary schools, a combined pass rate of at least 75 percent on English tests in grades 3-5 is required for full accreditation. Elementary schools also must achieve pass rates of at least 70 percent in mathematics, grade-5 science and grade-5 history, and pass rates of at least 50 percent in grade-3 science and grade-3 history.

Accreditation ratings may reflect adjustments made for schools that successfully remediate students who failed reading or mathematics tests during the previous year. Adjustments also may be made for students with limited-English proficiency and for students who have recently transferred into a Virginia public school.

Review of the Standards of Quality

The 2009 General Assembly added language to Item 140 of the Appropriation Act requiring the Board of Education to review the SOQ and submit a report by November 1, 2009. Specifically, Item 140 states:

> The Board of Education shall review the current Standards of Quality to evaluate the appropriateness of the existing staffing standards for instructional positions and the appropriateness of establishing ratio standards for support positions, with the objective of maximizing resources devoted to the instructional program. The findings of this review, its associated costs, and its final recommendations for rebenchmarking shall be submitted to the Governor, the Chairmen of House Appropriations and Senate Finance Committees and the Joint Subcommittee on Elementary and Secondary Education Funding established pursuant to Item 1, paragraph H. of this Act no later than November 1, 2009.

Between the spring and fall of 2009, the Board reviewed the Standards of Quality and solicited public comment. The Board began this important work through its Committee on the Standards of Quality. The committee set to work immediately by holding several forums with statewide professional organizations to hear comments and suggestions from key constituencies in the field. Additionally, the Department of Education, through the Request for Proposal process, commissioned a study of SOQ funding, which was completed by an outside vendor. Through this statewide, interactive process, the Board of Education adopted policy directions and recommendations that will be submitted for consideration by the 2010 General Assembly. The Board of Education's policy directions and recommended changes to the SOQ are detailed below. *(Text to be added here…)*

Closing Statement by the Virginia Board of Education

The Board of Education's priorities for action may be summed up as this: Our priorities are based upon a sincere expectation that every child will learn at a high level, that any traditional excuses for failure will be swept off the table, and that assessments will be used to guide the next lesson as well as evaluate the previous one.

The world in which we live—and certainly the one in which our children will live and work in the future—is constantly changing, constantly shifting. New technologies, new skills, and new ways of working emerge every day, and our schools must provide an education that promotes not just competence but *excellence*. Keeping our system of public schools on a steady course and continuing to deliver solid results despite huge challenges call for a keen sense of what is required to move from competence to excellence. It requires a steady focus on goals and on what needs to be our highest priority.

Education is the foundation for everything else we do, from economic development to health care. We are facing some difficult challenges today, but the key solution to these challenges remains the same: Be measured by strong academic standards, reach strong standards, and exceed strong standards. By doing so, young Virginians will surely lead the nation in educational progress. We are well on our way.

Appendices

Appendix A: Virginia Assessment Program Results: 2006-2007 through 2008-2009

Appendix B: Demographics of Virginia's Public Schools

Appendix C: List of School Divisions Reporting Full Compliance with the SOQ: 2008-2009

Appendix D. List of School Divisions Reporting Noncompliance with any Provision of the SOQ: 2008-2009

Appendix E: Divisions with All Schools Fully Accredited, Schools Granted Conditional Accreditation, Schools Rated Accredited with Warning, Schools Rated Accreditation Denied: 2008- 2009

Appendix F: Standards of Quality, as Amended by the 2009 General Assembly

Appendix A:
Virginia Assessment Program Results:
2006-2007 through 2008-2009
Reported by NCLB Subgroups

Assessment Results at each Proficiency Level by Subgroup

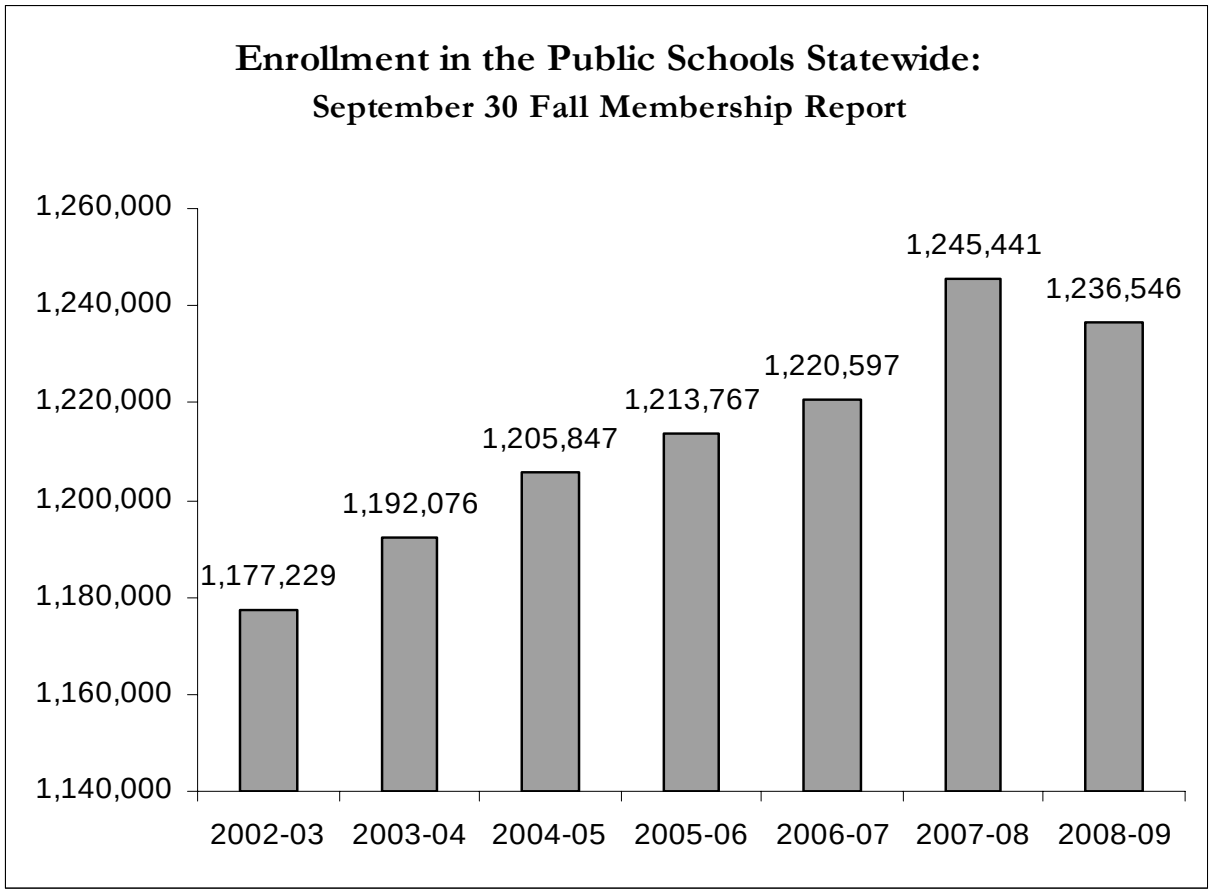
The Virginia Assessment Program includes Standards of Learning (SOL) tests and other statewide assessments in English, history/social science, mathematics, and science. The tables below provide information for the three most recent years on the achievement of students on these tests, including percentages of students who demonstrate proficiency and advanced proficiency. Annual accountability ratings are based on achievement during the previous academic year or combined achievement from the three most recent years. Only student subgroups represented are listed.

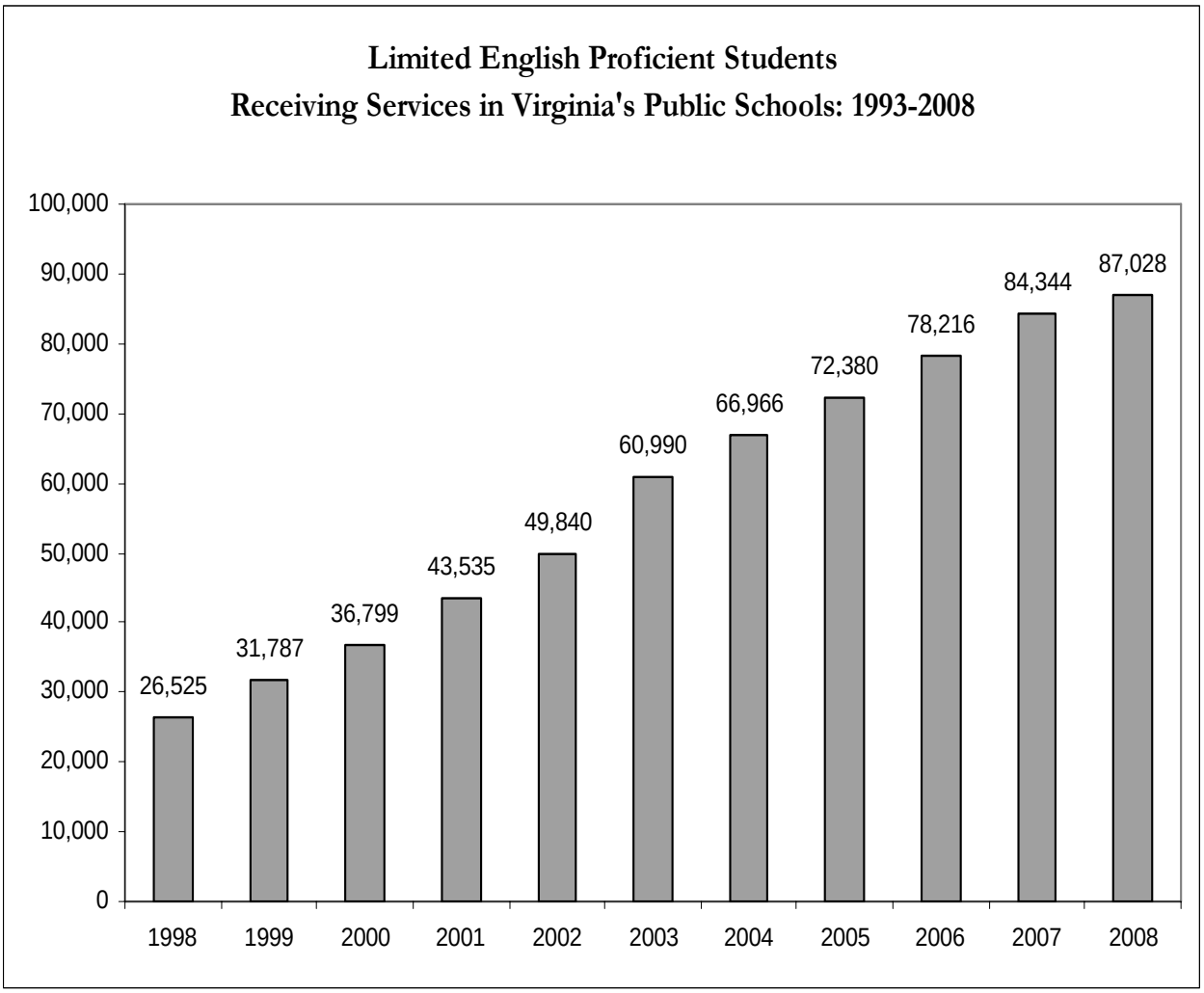
Tables begin on the next page:

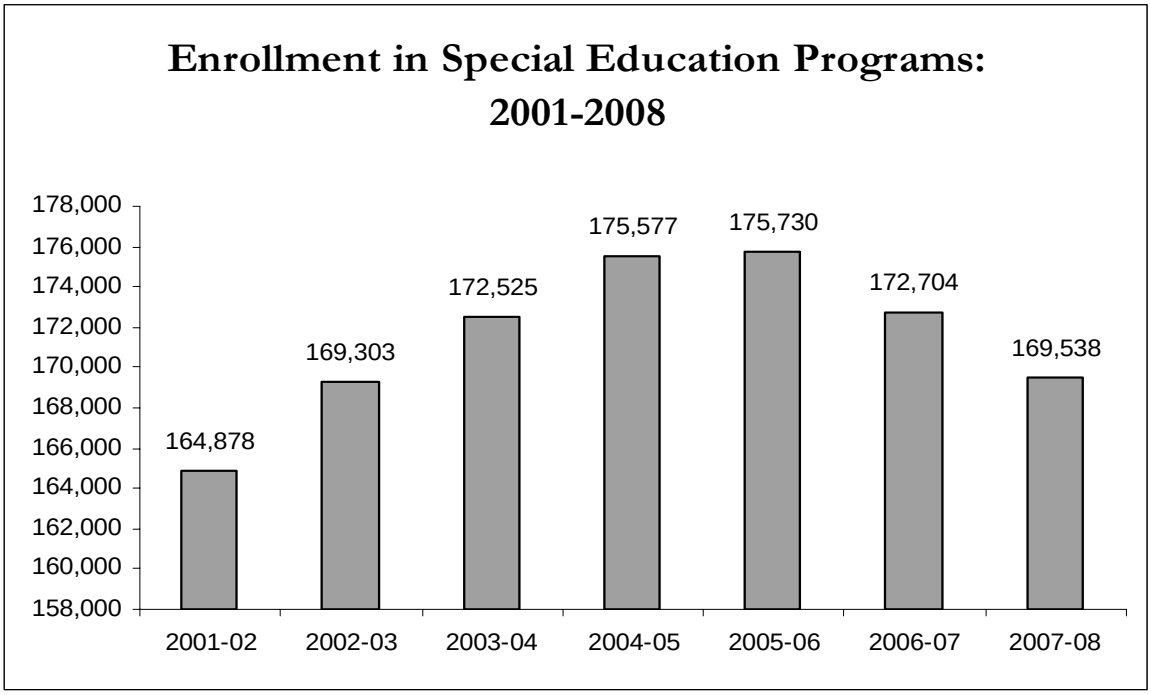
(Tables to be added here…)

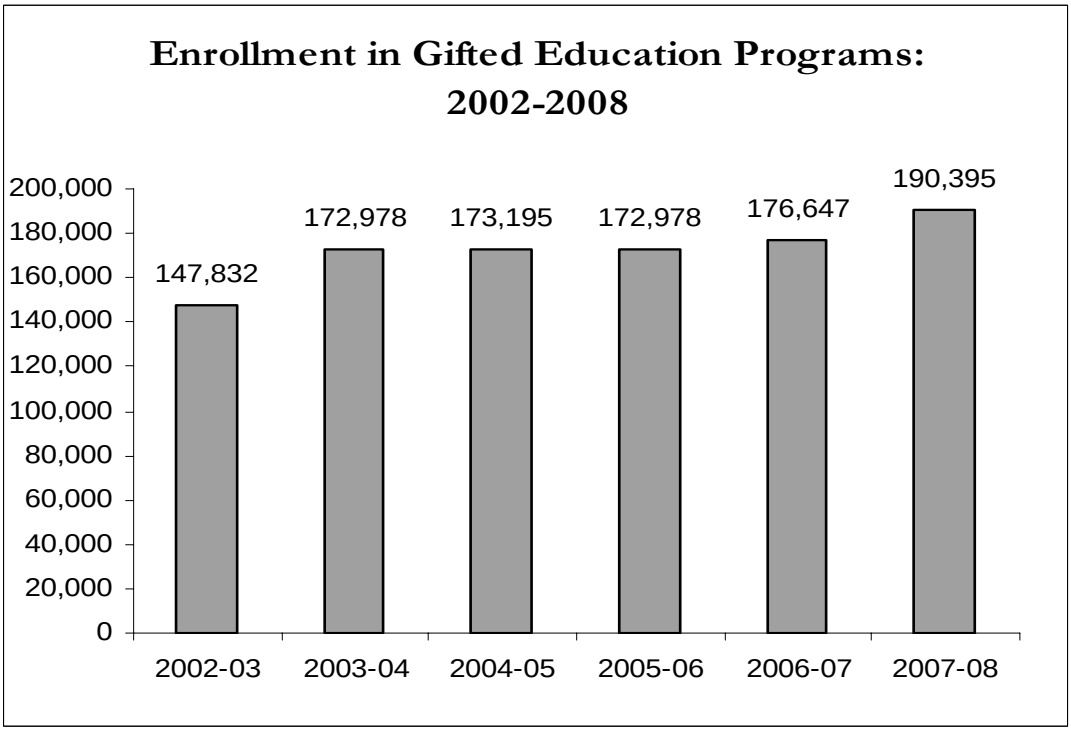
APPENDIX B:

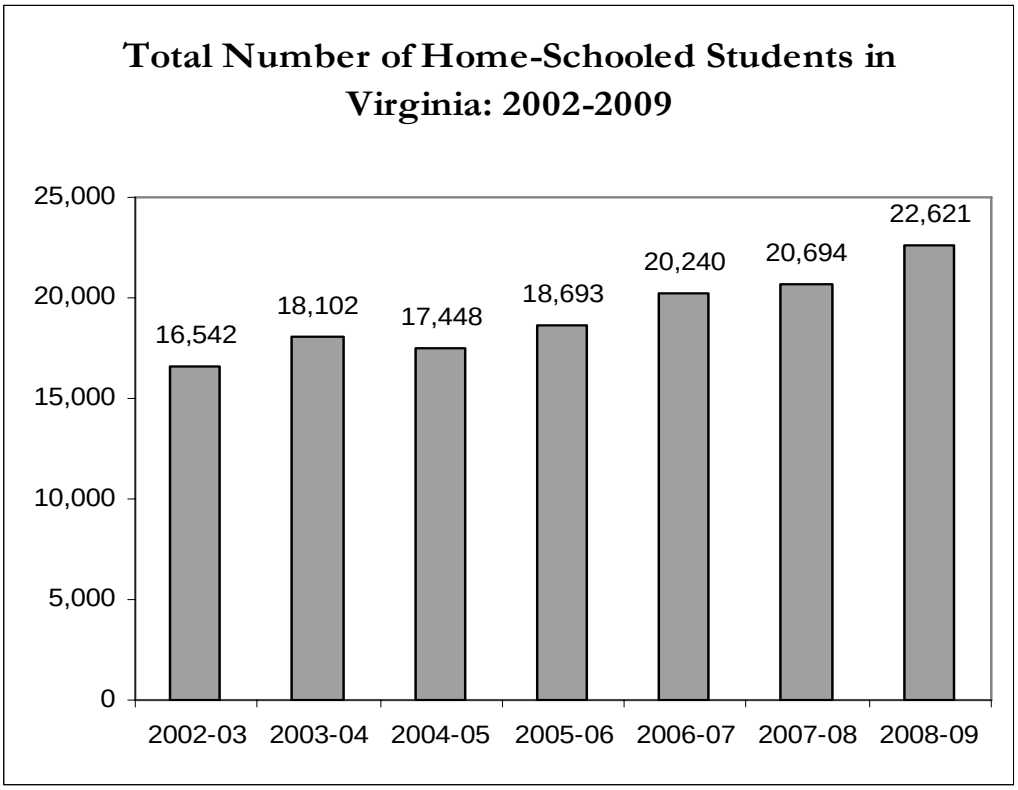
Demographics of Virginia's Public Schools




Limited English Proficient Students
Receiving Services in Virginia's Public Schools: 1993-2008
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
26,525
31,787
36,799
43,535
49,840
60,990
66,966
72,380
78,216
84,344
87,028
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008


Enrollment in Special Education Programs:
2001-2008
178,000
176,000
174,000
172,000
170,000
168,000
166,000
164,000
162,000
160,000
158,000
164,878
169,303
172,525
175,577
175,730
172,704
169,538
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08

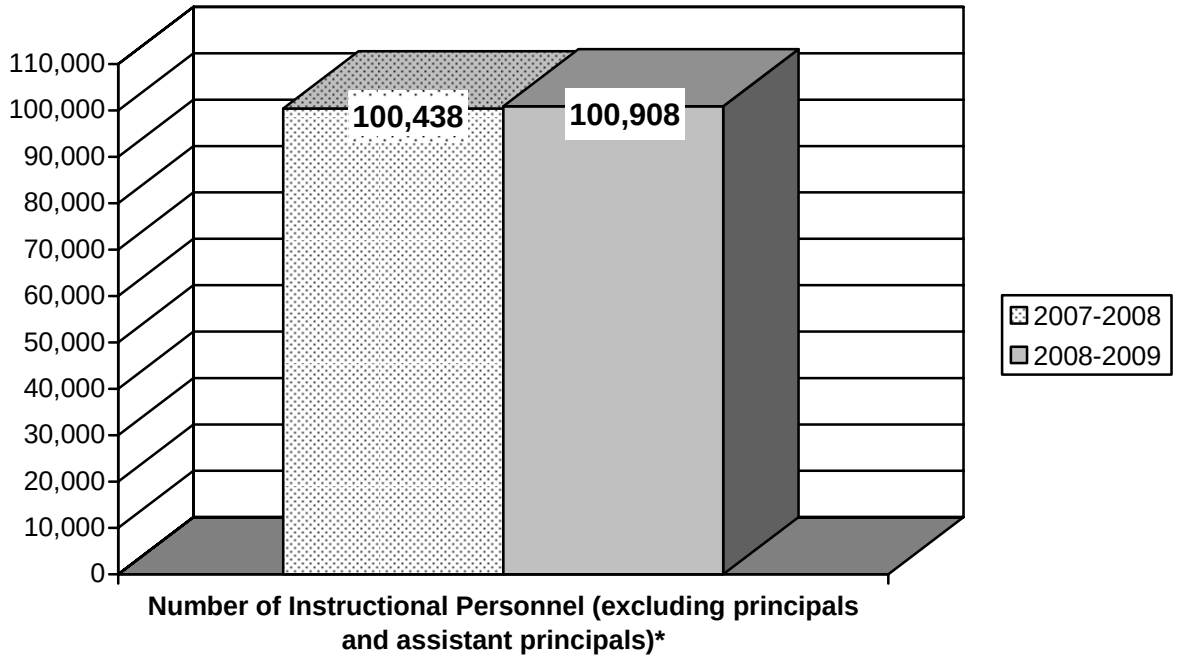

Enrollment in Gifted Education Programs:
2002-2008
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
147,832
172,978
173,195
172,978
176,647
190,395
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08



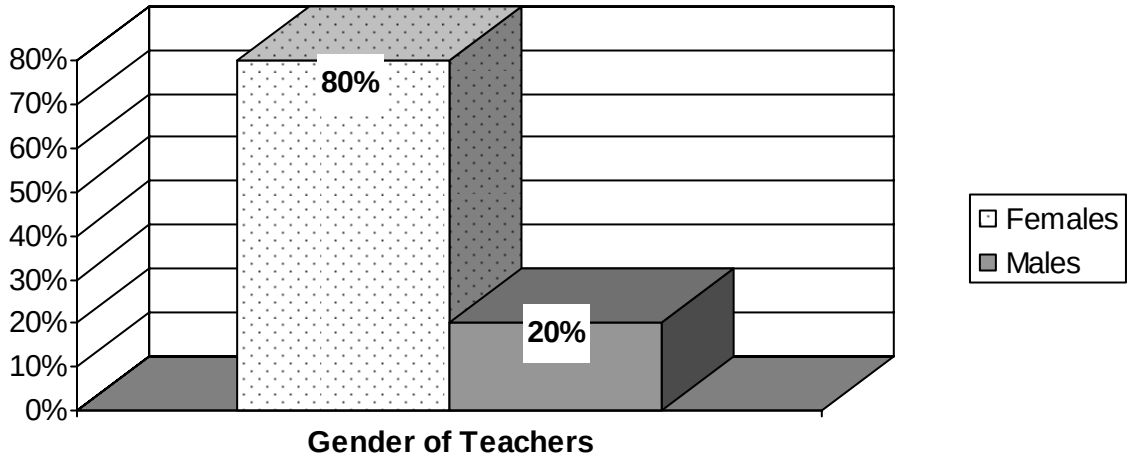
Number and Percent of Students Eligible for Free and Reduced-Price Lunch Program

Year	Eligible Students	Percent of Statewide Enrollment
2001-2002	348,880	31.30 percent
2002-2003	362,477	31.81 percent
2003-2004	374,437	32.63 percent
2004-2005	387,554	33.48 percent
2005-2006	387,847	33.11 percent
2006-2007	394,860	33.49 percent

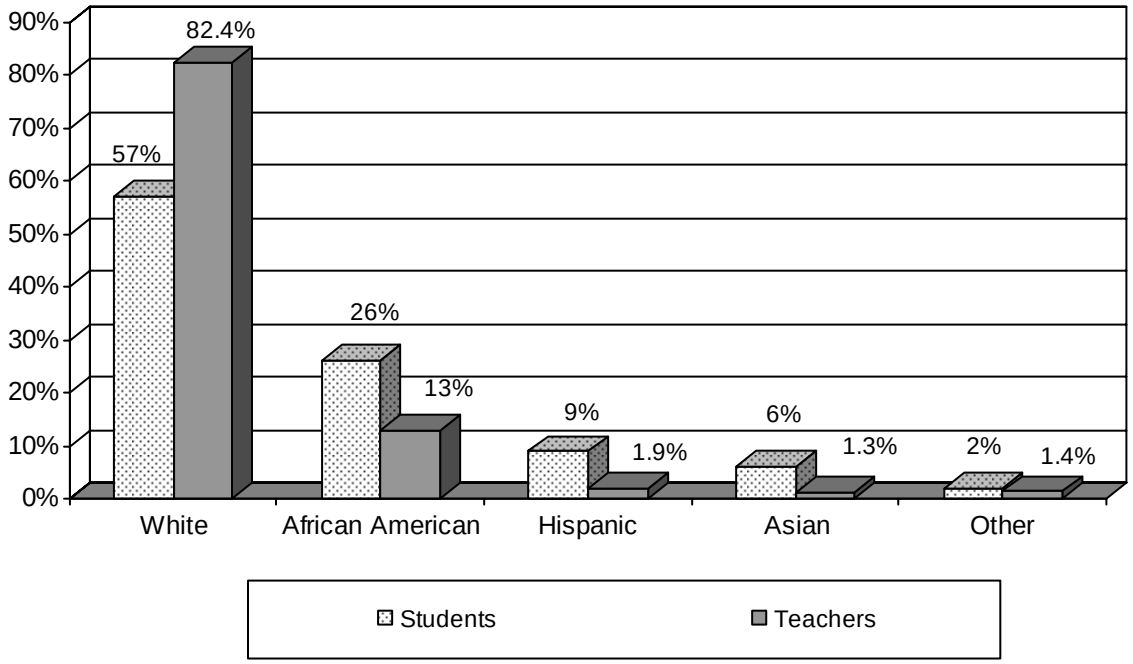
Number of Instructional Personnel (Excluding Principals and Assistant Principals)



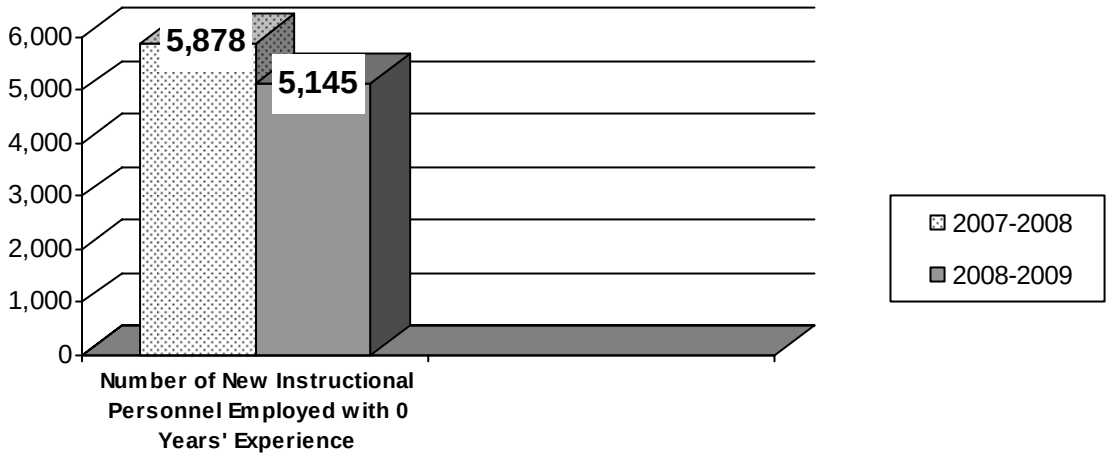
Gender of Instructional Personnel in Virginia's Public Schools: 2008-2009



Race/Ethnicity: Virginia Public Schools' Instructional Personnel and Students 2008-2009



Number of New Instructional Personnel (Excluding Principals and Assistant Principals) Employed by Virginia School Divisions 2007-08 and 2008-09 (New instructional personnel are defined as having 0 years' teaching experience)



General Fund (GF) Legislative Appropriations— Total State, Total K-12, Total Direct Aid to Public Education: FY 1995 through 2006

Fiscal Year	Total GF Appropriation for Operating Expenses	Total K-12 GF Appropriation	Total K-12 GF Appropriation as a % of Total GF Operating	Total Direct Aid to Public Education GF Appropriation	Total Direct Aid to Public Education GF Appropriation as a % of Total GF Operating
1995	7,355,695,733	2,547,067,019	34.6%	2,514,736,974	34.2%
1996	7,597,249,960	2,686,990,223	35.4%	2,658,572,757	35.0%
1997	8,134,360,672	2,930,985,574	36.0%	2,895,766,099	35.6%
1998	8,715,476,981	3,082,072,592	35.4%	3,046,807,462	35.0%
1999	9,967,431,115	3,534,978,628	35.5%	3,489,301,374	35.0%
2000	11,093,396,991	3,720,945,765	33.5%	3,673,762,807	33.1%
2001	12,283,610,813	4,007,068,597	32.6%	3,942,411,254	32.1%
2002	12,013,820,347	3,959,806,011	33.0%	3,895,682,317	32.4%
2003	12,105,186,620	3,980,489,954	32.9%	3,923,268,185	32.4%
2004	12,370,158,175	4,129,120,033	33.4%	4,069,907,268	32.9%
2005	13,781,896,827	4,719,699,883	34.2%	4,653,203,619	33.8%
2006	15,111,251,632	5,071,605,259	33.6%	4,998,052,047	33.1%
2007	16,779,048,401	5,770,433,215	34.4%	5,695,619,782	33.9
2008	16,982,495,713	5,933,601,634	34.9%	5,859,840,675	34.5%

Notes:

(Total For Part 1: Operating Expenses) in the appropriation act.

"Total K-12 GF Appropriation" is the total legislative general fund appropriation for Department of Education Central Office, Direct Aid to Public Education, and the two schools for the deaf and the blind.

"Total Direct Aid GF Appropriation" is the total legislative general fund appropriation for Direct Aid to Public Education.

The general fund appropriation for Comprehensive Services Act (CSA) is deducted from the Direct Aid totals for FY 1995 and FY 1996 since CSA was appropriated within Direct Aid for those years but outside Direct Aid in subsequent years.

For FY 1997 through FY 2006, CSA appropriations are not included.

The Direct Aid appropriation for FY 1999 and FY 2000 includes $55.0 million per year for school construction grants appropriated under Item 554 of Chapter 1072.

APPENDIX C:
Compliance with the Standards of Quality: 2008-2009

Divisions Reporting Full Compliance with All Provisions of the Standards of Quality for 2008-2009

(List to be added here…)

APPENDIX D:
Divisions Reporting Noncompliance with Certain Provisions of the Standards of Quality for 2008-2009

(List to be added here…)

Appendix E:

Divisions with All Schools Fully Accredited, Schools Granted Conditional Accreditation, Schools Rated Accredited with Warning, Schools Rated Accreditation Denied 2008- 2009

In 117 of the Commonwealth's 132 school divisions, all schools are fully accredited, compared with 96 last year. Divisions with all schools fully accredited (other than new schools that automatically receive conditional accreditation) are:

Accomack County
Alleghany County
Amelia County
Amherst County
Appomattox County
Arlington County
Augusta County
Bath County
Bedford County
Bland County
Botetourt County
Bristol
Buchanan County
Buckingham County
Buena Vista
Campbell County
Caroline County
Carroll County
Charles City County
Charlotte County
Charlottesville
Chesapeake
Chesterfield County
Clarke County
Colonial Beach
Colonial Heights
Covington
Craig County
Culpeper County
Cumberland County
Dickenson County
Dinwiddie County
Essex County
Fairfax County
Falls Church
Fauquier County
Floyd County
Fluvanna County
Franklin
Franklin County
Frederick County
Fredericksburg
Galax
Giles County
Gloucester County
Goochland County
Greene County
Greensville County
Halifax County
Hanover County
Harrisonburg
Henry County
Highland County
Hopewell
Isle of Wight County
King George County
King William County
King and Queen County
Lancaster County
Lee County
Lexington
Loudoun County
Louisa County
Lunenburg County
Lynchburg
Madison County
Manassas
Manassas Park
Martinsville
Mathews County
Mecklenburg County
Middlesex County
Montgomery County
Nelson County
New Kent County
Newport News
Northumberland County
Norton
Nottoway County
Orange County
Page County
Patrick County
Pittsylvania County
Poquoson
Portsmouth
Powhatan County
Prince Edward County
Prince George County
Pulaski County
Radford
Rappahannock County
Richmond County
Roanoke County
Rockbridge County
Rockingham County
Russell County
Salem
Scott County
Shenandoah County
Smyth County
Southampton County
Spotsylvania County
Stafford County
Staunton
Suffolk
Surry County
Tazewell County
Virginia Beach
Warren County
Washington County
Waynesboro
West Point
Westmoreland County
Williamsburg-James City Co.
Winchester
Wise County
York County

Schools Accredited with Warning

The number of schools accredited with warning fell to 17, compared with 54 last year. Forty-eight schools that were on academic warning last year achieved full accreditation.

Albemarle County	Albemarle County Community Public Charter School
Alexandria City	Jefferson-Houston Elementary
Brunswick County	James S. Russell Middle
Danville City	Langston Focus School
Grayson County	Fries Middle School
Hampton City	Jane H. Bryan Elementary
Henrico County	Highland Springs Elementary
Norfolk City	Lindenwood Elementary
Norfolk City	Ruffner Middle
Northampton County	Kiptopeke Elementary
Prince William County	Mills E. Godwin Middle
Richmond City	E.S.H. Greene Elementary
Richmond City	Fred D. Thompson Middle
Roanoke City	Westside Elementary
Sussex County	Sussex Central Middle
Wythe County	Fort Chiswell Middle
Wythe County	Scott Memorial Middle

Schools Conditionally Accredited

Six schools earned full accreditation after undergoing reconstitution and being conditionally accredited for one or more years. These schools are: Caroline Middle, Caroline County; New Bridge Alternative Middle, Henrico County; Westwood Middle, Danville; Brighton Elementary and Craddock Middle, Portsmouth; and Addison Aerospace Magnet Middle in Roanoke.

Under Virginia's accountability program, a school that has been on academic warning for three consecutive years and fails to meet state standards for a fourth consecutive year can apply to the Board of Education for conditional accreditation — if the local school board agrees to reconstitute the school's leadership, staff, governance or student population. A reconstituted school can retain conditional accreditation for up to three years if it is making acceptable progress toward meeting state standards.

Four schools were rated with conditional accreditation. These schools are:

- Lafayette Winona Middle and Northside Middle in Norfolk, given conditional accreditation for the first time; and
- Lake Taylor Middle in Norfolk and Thomas C. Boushall Middle in Richmond, given conditional accreditation for a third consecutive year.

Schools Rated Accreditation Denied

Ellen W. Chambliss Elementary in Sussex County was denied accreditation after not meeting state standards despite reconstitution and three years of conditional accreditation.

Two Petersburg schools — J.E.B. Stuart Elementary and Peabody Middle — were denied accreditation for a fourth consecutive year. A third Petersburg school — Vernon Johns Junior High — was denied accreditation for the third year in a row.

The status of A.P. Hill Elementary in Petersburg, which was the subject of a Virginia Department of Education investigation of assessment irregularities, will be determined by the Board of Education tomorrow. The board will determine the status of William Fleming High School in Roanoke, which also was the subject of a VDOE inquiry of testing practices, at its October meeting

Fourteen newly opened schools are automatically rated as conditionally accredited for 2008-2009.

Appendix G:
2009 STANDARDS OF QUALITY
Board of Education Recommendations to the 2010 Session of the Virginia General Assembly

(Text to be added here…)

Board of Education Agenda Item

Item: N. **Date:** October 22, 2009

Topic: Annual Report from the Virginia Council for Private Education

Presenter: Mr. George McVey, President, Virginia Council for Private Education

Telephone: 804/ 423-6435 **E-mail:** gjmcvey@vcpe.org

_X_ Topic presented for information only (no board action required)

____ Board review required by
- ____ State or federal law or regulation
- ____ Board of Education regulation
- _X_ Other: Board of Education Resolution

___ Action requested at this meeting

___ Action requested at future meeting

Previous Review/Action:

_X_ No previous board review/action

____ Previous review/action:
date:
action:

Background Information: At its meeting in November 1993, the Board of Education adopted a resolution that recognized the accrediting process for nonpublic elementary and secondary schools as administered through the Commission on Accreditation of the Virginia Council for Private Education (VCPE). The resolution was primarily for the purpose of public school acceptance of credits earned by students who attended such schools when they transfer to public schools and for any other such purpose(s) which may, from time to time, be specified by the *Code of Virginia* or as may be mutually agreed upon by the Board and VCPE. The resolution specifies, among other things, that the Board of Education will receive an annual report from VCPE.

A copy of the resolution is attached.

Summary of Major Elements: Mr. George McVey, president of VCPE, will present the annual report on behalf of his organization.

Superintendent's Recommendation: N/A

Impact on Resources: N/A

Timetable for Further Review/Action: N/A

Virginia Board of Education Resolution

Recognizing VCPE: Accrediting Nonpublic Elementary and Secondary Schools

Resolution Number 1993-6 **November 15, 1993**

WHEREAS, the *Code of Virginia* requires that all children who are five years old by September 30 and not older than 18 attend a public or private or parochial school to satisfy compulsory attendance laws; and

WHEREAS, the Virginia Council for Private Education (VCPE) was organized in 1974 as the Virginia affiliate of the National Council for American Private Education (CAPE) for purposes including "the encouragement of a broad public commitment to excellence in education"; and

WHEREAS, the VCPE established a Commission on Accreditation in July, 1985, "...for the purpose of approving appropriate accreditation processes for nonpublic schools in order to secure recognition for those schools by the State Department of Education"; and

WHEREAS, the Board of Education ceased accrediting nonpublic schools, and at its meeting on April 25, 1985, approved recommendations affecting the relationship of nonpublic schools and the Department of Education; and

WHEREAS, the Department of Education has maintained and fostered an ongoing and viable relationship with the VCPE since that time; and

WHEREAS, the 1993 General Assembly of Virginia amended sections of the *Code of Virginia* relating to the licensure of child day care centers which included an exemption for "a certified preschool or nursery school program operated by a private school which is accredited by a statewide accreditation organization recognized by the State Board of Education..."; and

WHEREAS, the Board is desirous of reaffirming and strengthening its relationship with the VCPE;

NOW, THEREFORE BE IT RESOLVED that the Board recognizes the accrediting process for nonpublic elementary and secondary schools as administered through the Commission on Accreditation of the Virginia Council for Private Education (VCPE) primarily for the purpose of public school acceptance of credits earned by students who attended such schools when they transfer to public schools and for any other such purpose(s) which may, from time to time, be specified by the *Code of Virginia* or as may be mutually agreed upon by the Board and VCPE; and

BE IT FURTHER RESOLVED that the Board will periodically review this recognition to ensure its continued relevancy and currency and the Superintendent of Public Instruction, or his designee, shall maintain contact with the VCPE and shall meet with its membership at least annually. Further, the Superintendent shall advise the Board on educational issues of concern to the VCPE.

Adopted in the Minutes of the Virginia Board of Education
November 15, 1993