Grade Six Science Standards of Learning for Virginia Public Schools – January 2010

Introduction

The *Science Standards of Learning* for Virginia 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 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.

Five key components of the science standards that are critical to implementation and necessary for student success in achieving science literacy are 1) Goals; 2) K-12 Safety; 3) Instructional Technology; 4) Investigate and Understand; and 5) Application. 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.
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, video-microscopes, graphing calculators, probeware, geospatial technologies, online 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 natural world. The application of science to relevant topics provides a context for students to build their knowledge and make connections across content and subject areas. This includes applications of science among technology, engineering, and mathematics, as well as within other science disciplines. Various strategies can be used to facilitate these applications and to promote a better understanding of the interrelated nature of these four areas.

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 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 and can predict potential consequences of actions, but cannot be used to answer all questions.

Scientific Investigation, Reasoning, and Logic

6.1 The student will 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) precise and approximate measurements are recorded;
c) scale models are used to estimate distance, volume, and quantity;
d) hypotheses are stated in ways that identify the independent and dependent variables;
e) a method is devised to test the validity of predictions and inferences;
f) one variable is manipulated over time, using many repeated trials;
g) data are collected, recorded, analyzed, and reported using metric measurements and tools;
h) data are analyzed and communicated through graphical representation;
i) models and simulations are designed and used to illustrate and explain phenomena and systems; and
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;
d) renewable energy sources; and
e) energy transformations.

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 Earth's surface. Key concepts include

a) 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 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 consist of particles, including electrons, protons, and neutrons;
b) atoms of a particular element are alike but are different from atoms of other elements;
c) elements may be represented by chemical symbols;
d) two or more atoms 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 phases;
c) the action of water in physical and chemical weathering;
d) the ability of large bodies of water to store thermal energy and moderate climate;
e) the importance of water for agriculture, power generation, and public health; and
f) 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 Earth's atmosphere. Key concepts include

a) air as a mixture of gaseous elements and compounds;
b) pressure, temperature, and humidity;
c) 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.

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 interactions among the various bodies that comprise it. Key concepts include

a) the sun, moon, Earth, other planets and their moons, dwarf planets, 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 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;
b) management of nonrenewable resources;
c) the mitigation of land-use and environmental hazards through preventive measures; and
d) cost/benefit tradeoffs in conservation policies.