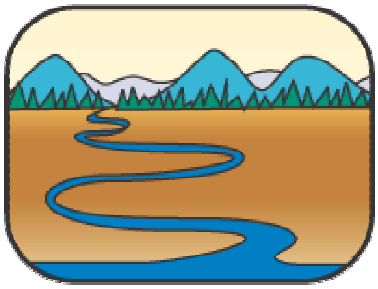


Lessons from the Bay

Process Model

Introduction

The *Lessons from the Bay* process model focuses on the Chesapeake Bay watershed as a framework for student learning in a variety of areas, including

- general knowledge
- knowledge within disciplines
- thinking and problem solving
- basic life skills, such as cooperation and interpersonal communication
- appreciation for the Chesapeake Bay watershed.

The model uses the natural and the socio-cultural environments as the contexts for learning, while taking into account the effective practices of successful educators. It combines these approaches in a way that

- constructs connections between disciplines, a task at which elementary and middle school teachers are especially adept
- provides hands-on learning experiences, often through problem-based learning
- relies on team-teaching, which gives students the benefit of two or more sets of expertise
- adapts to individual students, taking into account their unique skills and abilities
- develops knowledge, understanding, and appreciation for the environment, which includes both the community and the natural surroundings
- provides students with a meaningful watershed field experience on or near school grounds.

Although the model focuses on learning about the environment, it is not limited to the discipline of science. Teachers may use the model for any curriculum area. The model simply uses a school's surroundings and community as a framework within which students can construct their own learning, guided by teachers and administrators, using proven educational practices.

Patterned after Sunal and Sunal's learning cycle, the model begins with *exploration*, so that instruction can be developed around a context or issue of interest to the students; it then moves to *invention*, enabling students to gain new knowledge; and it provides students with an *expansion* for applying the concepts that they learn. To profit from their learning, students need to keep track of the project from beginning to end. They must record what they do and learn along the

Teacher Planning Activity:
Environmental Attitudes, Knowledge, Skills, and Behaviors

Think about the specific environmental attitudes, knowledge, skills, and behaviors that you would like students to develop during the unit.

As visual tools for constructing knowledge, graphic organizers may be helpful in the design of your unit and in your work with the students. (See Environmental Attitudes, Knowledge, Skills, and Behaviors handout, page 13.)

Teacher Planning Activity:
Story Line

Brainstorm ways to make your unit compelling to the students. What is the exciting narrative behind the work you and your students will be doing?

A story must have a beginning, middle, and end. How will you introduce the narrative?

- *You could show a large, color still photo or video of a local community or natural setting and have students consider the plants and animals depicted. They could describe a typical day in the life of an animal or plant, or contrast a sunny and a rainy day, or a summer and a winter day in the animal's life.*
- *You could play an audio tape with several different bird calls, have the students distinguish among the calls, and then ask them to describe or draw the setting as they imagine it to be.*

What are other possibilities? The story line will provide a way to hook your students into the unit.

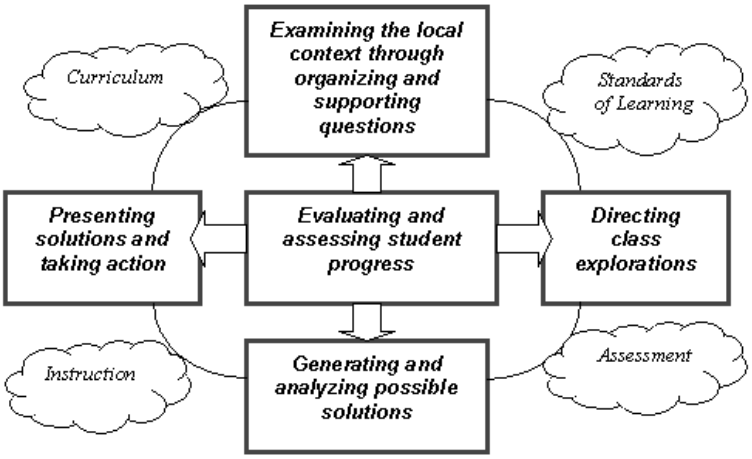
way. Their documentation should include

- research gathered and sources of information consulted
- investigations and observations (including data)
- learning and personal accomplishments
- actions taken.

To facilitate student learning, the model provides teachers with a process for planning and organizing their units, to include

- examination of local context
- class exploration
- generation and analysis of possible solutions
- solution and action.

As they follow this process, teachers will reinforce the principles of scientific investigation, reasoning, and logic, as outlined in the Virginia Standards of Learning for Science. In addition, they will help students apply the methodology of scientific inquiry to a variety of disciplines as the class discovers the mysteries and importance of the Chesapeake Bay watershed.



Lessons from the Bay Process Model

Teacher Planning Activity:
Brainstorming Contexts
What are the contexts in your area for studying the Chesapeake Bay watershed?

Sometimes it is helpful to brainstorm the various settings available to you and your students. You could start by thinking small, then moving to a broader context. (See Brainstorming Contexts handout, page 15.)

Planning Process for the *Lessons from the Bay* Model

Examining the Local Context

The Chesapeake Bay is an abundant context for learning. Investigating the watershed often begins in a classroom but soon moves beyond the traditional classroom walls. Teachers may choose to focus activities on one or more of a wide range of settings:

- classrooms or other in-house facilities, such as laboratories
- developed areas of school campus, including playgrounds or athletic fields

- undeveloped school property, such as fields and woodlands
- on-site study areas, such as the parking lot
- off-site study areas, including both natural habitats and community settings.

With the teacher's guidance, a class might select as their center of interest for learning about the Chesapeake Bay watershed a context, such as one of the following:

- a creek running behind the playground
- a schoolyard as a habitat for plants
- a schoolyard as a habitat for animals
- a small plot of grass in the schoolyard
- a parking lot near the schoolyard
- the landscaping on or near the schoolyard (including native and introduced species).

Teachers and students will find additional contexts for learning that are specific to their local surroundings.

Developing Organizing Questions and Supporting Questions

The chosen context for learning will form the basis for students to investigate an issue, problem, or unusual situation. Focus for the investigation should evolve through careful questioning on the part of the teacher.

Organizing Questions

Organizing questions are the "big picture" questions. They can engage students in meaningful exploration of the community and local environment. Posed by the teacher, organizing questions provide students with a framework for learning in many areas: general and disciplinary knowledge; thinking and problem-solving skills; basic life skills; and understanding of their local environment as it relates to the Chesapeake Bay watershed.

Effective organizing questions are those that

- arouse and sustain student interest
- encompass both natural and social systems and topics
- encompass the essential Science Standards of Learning content to be covered
- stimulate inquiry and focus student work
- allow for creation of interdisciplinary activities and investigations
- require students to propose and evaluate a variety of solutions rather than lead to one "obvious" response or one "right" answer
- are stated in language easily understood by students
- are related to everyday life

Teacher Planning Activity:
Using KWL Charts

At the beginning of the questioning process, Know-Wonder-Learned (KWL) charts are an effective way to identify what students already know about a topic, determine what they would like to learn or discover, and assess their progress as the unit proceeds.

The chart will also provide a way to assess what the students have learned. Teachers can make KWL charts on large sheets of paper (they can use an electronic table or spreadsheet) and have students revisit the charts periodically to fill in the "Wonder" and "Learned" columns. The "Learned" column can get very long, so it is important to leave a great deal of space. (See KWL Chart handout, page 17.)

Teacher Planning Activity:
Developing Questions

Create a Web diagram with an organizing question in the center and the supporting questions radiating from the center. (See Web of Questions handout, page 19.) The supporting questions must focus on the organizing question.

Student Activity:
Developing Questions
Once a few organizing questions and several supporting questions are developed, the students should work through the same activity. The students could create a graphic organizer, such as that in the Brainstorming Questions handout on page 21.

Teacher Planning Activity:
Generating Supporting Questions by Discipline
One of the purposes of the Lessons from the Bay *planning process model is to construct connections between disciplines. "Bridge" questions can help you analyze a situation from the perspective of multiple disciplines.*

Let the Bridge Questions handout on page 23 assist you in constructing your supporting questions for each subject area. Collaborate with other teachers at your school to think of more interdisciplinary connections.

Teacher Planning Activity:
Making Interdisciplinary Connections
To go a step further and fully integrate several subject areas into the Lessons from the Bay *model, you may wish to map your plan. Setting up a chart can ensure that all selected disciplines are covered and that each is sustained throughout the learning process. (See Making Interdisciplinary Connections handout, page 25.)*

- require students to revisit the problem frequently as knowledge and understanding evolves
- recur naturally throughout the completion of an interdisciplinary program.

Prior to class time, teachers should determine (1) what question they want the students to answer or (2) what question to use as an example so that students can determine a question they as a class would like to answer.

Examples of organizing questions

- *What impact does our school have on the Chesapeake Bay?*
- *In what ways does development in our community affect the Chesapeake Bay?*
- *How does the Chesapeake Bay affect the economy of our community?*
- *In what ways does our school parking lot affect the natural systems of a nearby stream?*
- *Does our schoolyard provide a healthy habitat for a wide variety of organisms?*
- *What vegetation can we plant in our schoolyard to attract native animals?*

It would be helpful for the teacher to keep his or her questions in mind while taking the class on a tour of the schoolyard. Stopping frequently for the class to make observations about their surroundings may increase the likelihood that students will develop thought-provoking questions.

Supporting Questions

Students will not have enough knowledge at the start of the project to answer the organizing question. Therefore, teachers must generate supporting questions that will help students find the missing information needed to answer the organizing question. These smaller, supporting questions can help provide direction and keep the class moving if students are stumped.

Before presenting an organizing question to the class, teachers should determine what major concepts will be involved and should prepare supporting questions that introduce the concepts. A good initial brainstorming technique here is to create a large web of supporting questions that branch out from the organizing questions.

As they generate supporting questions, teachers will want to include questions that bring in a variety of subject disciplines: English, science, mathematics, and history and social science, as well as other areas that may apply.

To illustrate, if the classroom focus is to be biodiversity, the teacher may first need to introduce the concept of habitat and the idea that different animals need different environmental conditions to survive. The teacher may ask supporting questions such as

- *What is an animal that you can see near the school?*
- *What do you see this animal doing during the day?*
- *What does it eat?*

- *What does it drink?*
- *Where does it sleep?*
- *What dangers does it face?*
- *How does it stay safe?*
- *What things does it need in order to live?*
- *Have there always been animals of this type around here?*
- *How many of these animals do you think live in this area?*
- *Why are there so few (or so many) of these animals around here?*

The organization question that could then be asked of the students is "How could we increase the number of animals living on or near our school grounds?"

Using Research to Gain Deeper Understanding

Information and Resources

Once the class has determined the context (i.e., where to conduct the watershed fieldwork) and the organizing and supporting questions, the teacher should direct students to resources that provide a deeper understanding of the topic. As students learn to keep records of their research, teachers have an opportunity to introduce the basic purpose and components of a bibliography. (See "Using the Library Media Center for Project Research" on page 55 of the **Project Action Guide** section of this document.)

Fieldwork (Investigations)

The students should also be making and recording observations that will help them to answer their supporting and organizing questions. For instance, the class may decide that they need to know what kinds of plants and animals are living on their school grounds to determine the health of their schoolyard. The students may go to the schoolyard and count the number of different plants and animals they see living nearby. Authentic data collection is an important skill that will allow a student to experience genuine scientific procedures. (See "Keeping a Journal" on page 49 of the **Project Action Guide**.)

As fieldwork progresses, the students will begin to hypothesize answers to their questions. Questioning is important not just in planning, but throughout the learning process. As students enter the investigative stage of the project, questions from the teacher and classmates may help students see different routes to a solution and spur subsequent exploration and new hypotheses. Such questions might take many forms:

- *What exactly are we doing?*
- *What would happen if you changed this?*
- *What would happen if we try the same thing over here?*

When students are ready to propose explanations, questions help to clarify, justify, and in some cases alter their thinking:

- *Did anything you discover surprise you?*
- *What do you have to say about your classmate's answer?*

Teacher Planning Activity:
Performing Research

You will want to do your own research in preparation for the students' search for resources:

- *Books, magazines, audiovisual items, maps, and reference materials from your media center*
- *Commercial textbooks*
- *Booklets, brochures, or maps published by state, national, and local government agencies*
- *Materials and speakers from museums and other related organizations*
- *Teaching colleagues with discipline specialties or interests complementing yours*
- *Age-appropriate Web sites that focus on the issues raised in your organizing questions*

*See information on research skills, pages 55–58 of the **Project Action Guide**.*

Student Activity:
Documenting Research

Students may benefit from a formatted worksheet to keep track of their resources. (See Student Resource Chart handout, page 27.)

Student Activity:
Recording Data

As your students begin gathering observations, they may find it helpful to use a standard format for recording data collected. (See Data Collection Sheet handout, page 29.)

Teacher Planning Activity:
Lessons from the Bay Lesson Plans
*The **Lesson Plans** section of* Lessons from the Bay *is a resource for investigations and activities a teacher may want to use with the students. Each lesson may be used as is, adapted, or used as a template for the teacher's own activities and investigations.*

Teacher Planning Activity:
Continuing the KWL Chart
Return to your KWL chart and begin completing the "Wonder" column.

Teacher Planning Activity:
Continuing Interdisciplinary Connections
As students begin to generate and analyze possible solutions, you should return to your own Interdisciplinary Connections chart, concentrating on the "Activity or Investigation" column.

Student Activity:
Testing the Hypothesis
*Students should continue to document their group's findings by listing ideas for testing their hypothesis. Other student activities are suggested in the **Lesson Plans**.*

Teacher Planning Activity:
Facilitating Groups
*The **Project Action Guide** is an invaluable resource for organizing cooperative learning groups. (See especially pages 5–6.)*

Generating and Analyzing Possible Solutions

Once the students have acquired the background information needed to begin answering their supporting and organizing questions, they should work in small groups or as a whole class to generate possible solutions. The students should list their ideas for solutions and develop ways to test their hypothesis.

For instance, the students may decide that the reason there are so few plants and animals on the school grounds is that the grounds do not contain a healthy environment for the plants and animals to live. A possible solution would to be to create a habitat for plants and animals around the school campus. The students could create a small wetland area on the schoolyard or near the school's property.

Often, the process of generating and implementing a solution sets into motion another organizing question and set of supporting questions. As in the example above, if students should decide to create a wetland area, their new organizing question would be: "How can we establish and maintain a wetland habitat in our schoolyard?" The supporting questions could include

- *Where is the best spot for a wetland?*
- *What kinds of plants will we need?*
- *How will we raise money to purchase plants we need?*

Even after a solution has been implemented, the learning can continue. The students should analyze their solutions to see if they have determined an answer to the problem. If they find that the problem still exists, they will need to return to the identifying information and resources and work through the process again. If they decide that they have determined a solution to the problem, then they may move on to the next step in the process.

For example, to solve the biodiversity problem on their school grounds, a group of students restored a small wetland area. To see if their project had worked, the students went back a month later and counted the number of animals living in the restored area. They found that they now had several new species living on their school grounds. From this they determined that their hypothesis was correct: the reason for the lack of animals on their school grounds was that there was no nurturing place for the animals to live.

Throughout the process of generating and analyzing solutions, teachers play an important facilitation role by forming groups, observing, moderating, answering questions, encouraging the flow of ideas, and synthesizing findings. Teachers must be careful to put together groups that best benefit the learner by taking into account students' interests, abilities, and behaviors.

With their many opportunities for group work, watershed lessons and projects offer excellent contexts for students to develop positive interpersonal relations skills and practice cooperative learning. Research presented by Johnson, Johnson, and Holubec suggests that there are three basic components of cooperative learning:

Positive interdependence. Students must recognize that they need one another to complete the task. That is, they can reach their learning goals if and only if all other students in the group reach their learning goals too.

Face-to-face interaction. Students must be in situations where they help one another learn and complete the learning task. That is, they explain, discuss, teach, and make connections among concepts.

Individual accountability. Groups are designed to help everyone learn, but individual students have the ultimate responsibility for their own learning. One of the concerns in the use of small groups is the so-called "hitchhiker" problem, where certain students do the majority of the work and assessment. Teachers who spend time explaining the reasons for cooperative group work and who do not grade on a curve do not often report the hitchhiker problem.

Encouraging Solution and Action

It is important to have the students communicate to others what they have found. Presentation of the solution helps the students take ownership in the scientific process that they have followed to reach their conclusion. The students' ongoing documentation is an important part of preparing for this presentation.

Teachers will want to emphasize group and individual oral skills at this stage, including both speaking and listening skills.

Once the presentation is completed, it is essential to instill in the students the concept that their discoveries can be applied elsewhere. A concluding round of questions can stimulate students to act on what they have learned:

- *Where could you get more information on this topic?*
- *How could what you learned here fit in other situations? At home? In community projects?*

Teachers should have the students move beyond the classroom and school grounds and apply the knowledge they have learned to other situations. Now that they have determined a way to solve the problem, they are ready to address the problem situation on a larger scale.

One example may be to have the students explore home applications of the scientific inquiry process. Students could brainstorm potential organizing questions:

- *What impact does my yard [or my neighborhood] have on the Chesapeake Bay?*
- *What improvements can I make to my yard so that it has a better impact on the Bay?*
- *What plants can be added to my yard to attract native animals?*
- *What are the pros and cons of attracting native animals to my yard?*

Another approach would be to have students participate in a community restoration project or clean-up effort. A grade level may

Teacher Planning Activity:
Facilitating Group Work
*You may wish to consult the **Project Action Guide** in this document for resources on group work and presentations. (See **Project Action Guide**, pages 5–6.)*

Student Activity:
Organizing the Presentation
Student groups may profit from a presentation worksheet to organize their presentation. You may wish to provide each group with a folder where they can keep all their research, observation data, and other documentation in one central place. This information should form the basis for their presentation. (See Planning Your Presentation handout, page 31.)

Teacher Planning Activity:
Broadening the Scope
*In the **Project Action Guide** of this document, you will find numerous ideas for applying the students' newly acquired scientific inquiry skills to larger issues and new situations, such as school, community, or home projects.*

Teacher Planning Activity:
Continuing Interdisciplinary Connections
You should return once again to your Interdisciplinary Connections chart, concentrating on the "Assessment" column.

Teacher Planning Activity:
Developing Authentic Assessment
How can a student's ability to do scientific inquiry be assessed? One approach would be to challenge the students to apply their newly gained skill to a case study or simulation. Portfolios are another proven authentic assessment tool.

Bringing in outside experts or engaged community members as an audience for a presentation or demonstration can help reinforce for students the real-world importance of their newly acquired skills.

To explore the possibilities for authentic assessment, see the following:

- *"Assessment and Evaluation." MiddleWeb. (http://www.middleweb.com/ ContntAssess.html)*
- *"The Case for Authentic Assessment," by Grant Wiggins (ERIC Digest # ED328611) (http://www.ed.gov/databases/ ERIC_Digests/ed328611.html)*

For authentic assessment applications and resources, see the ***Lesson Plans*** *as well as "To the Teacher" on pages 5–8 of the* ***Project Action Guide****.*

Teacher Planning Activity:
Continuing the KWL Chart
Return to your KWL chart to complete the "Learned" column.

be interested in collecting data each year. If the school intends to repeat large efforts on an annual basis, it would be important to have the project inserted into the school/division curriculum.

Using Authentic Assessment

Quizzes and tests certainly have a role in education for assessing how well students have picked up factual information, concepts, and discrete skills. Because assessment is a feedback mechanism, however, assessments must reflect what teachers want students to know and be able to do. If scientific inquiry is important, then a student's ability to do scientific inquiry should be assessed in a way that enables them to show what they have learned. One way is through authentic assessment.

For the purpose of this guide, the term *authentic assessment* refers to assessment by performance, task, product, or project. Authentic assessment asks students to apply what they have learned in such a way that it provides evidence of in-depth understanding, rather than of superficial or naive understanding (Wiggins and McTighe). In authentic assessment, teachers ask students to provide evidence that they have "gotten it" by actually doing something real. Often, such assessments include an authentic audience—real stakeholders to whom the students present information or with whom they otherwise engage.

As students construct meaning from their inquiries, not all students, no matter how hard teachers work with them, will arrive at the proper scientific conceptions. The fact that some students have failed to grasp the principles of scientific inquiry is often hidden when conventional, multiple-choice tests are used. What this means for assessment and evaluation is that assessment must be process-oriented. In assessing, teachers may want to consider questions such as the following:

- *What are the contributions of the students?*
- *Are the claims viable in terms of the data collected (including claims made by students who enter and pursue blind alleys in their research)?*
- *How creative are the research questions?*
- *Are the findings consistent with currently held views?*
- *What skills did the students use, and how well were they used in the process of finding answers to questions?*

The design and content of an authentic assessment may depend upon how the students' project has evolved. But in any case, if scientific inquiry is an important factor in the project, the assessment should compel students to show clear evidence of understanding the "big picture" of scientific inquiry (from organizing and supporting questions, through research and data collection, to hypothesis testing and action).

Once the "big picture" or central learning of a unit has been identified, criteria for judging student learning should be developed. Checklists are a useful way of displaying criteria. Teachers can assign points to a checklist against a standard, although assigning points is not necessarily straightforward. Students should have access to the

checklists as they perform. These tools can also make a judgment about the quality of their work, and this can be used as the basis for a discussion with them about their progress throughout the project.

Summary

Classroom use of the **Lesson Plans** and the **Project Action Guide** should involve process as both a means and an end. The hope is that through following the **Process Model**, students will gain valuable knowledge about the Chesapeake Bay watershed and its importance to them and to their community. It is also hoped that students will learn the basic principles and techniques of the process of scientific inquiry and will begin to apply these principles elsewhere at school, at home, and in the community.

Resources

"Assessment and Evaluation." *MiddleWeb.* <http://www.middleweb.com/ContntAssess.html>.

Johnson, D.W., and R.T. Johnson. Cooperative Learning Center, University of Minnesota. <http://www.clcrc.com/pages/cl.html>.

Johnson, D.W., R.T. Johnson, and E.J. Holubec. *Cooperation in the Classroom*. 6th ed. Edina: Interaction, 1993.

Sunal, D.W., and C.S. Sunal. *Science in the Elementary and Middle School*. Upper Saddle River: Prentice-Hall, 2003. ISBN 0130283428.

Wiggins, G.P. "The Case for Authentic Assessment." *ERIC Digest* # ED328611. U.S. Dept. of Education. <http://www.ed.gov/databases/ERIC_Digests/ed328611.html>.

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