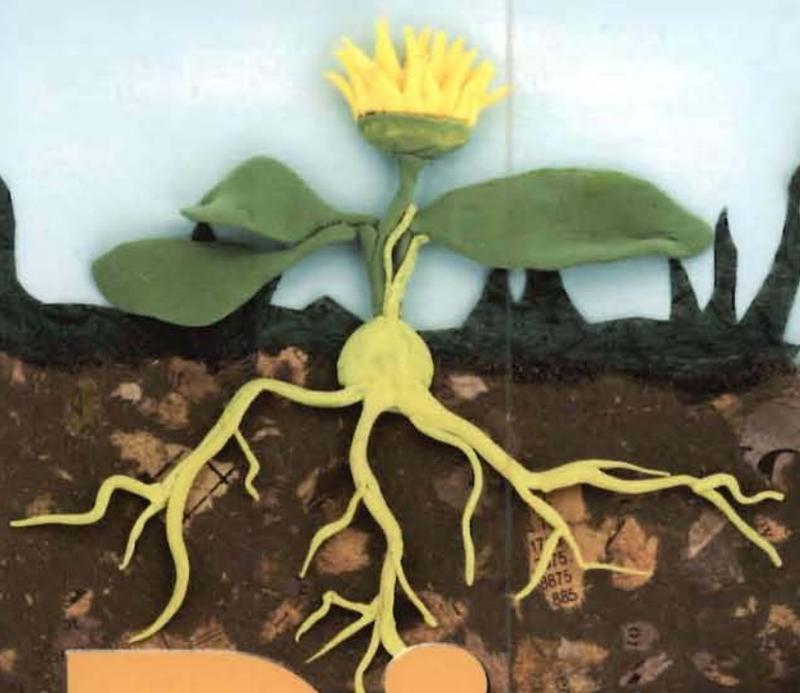
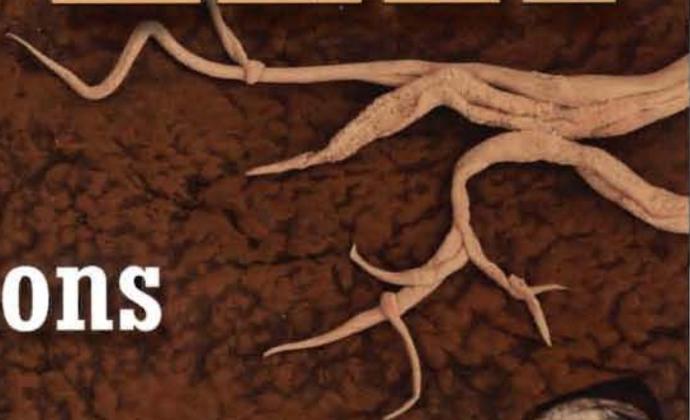


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# Dig In!

Hands-On  
Soil Investigations



**NSTA**press  
NATIONAL SCIENCE TEACHERS ASSOCIATION



**Dig In!**  
**Hands-On Soil Investigations**





## Hands-On Soil Investigations



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**NSTA**press  
NATIONAL SCIENCE TEACHERS ASSOCIATION

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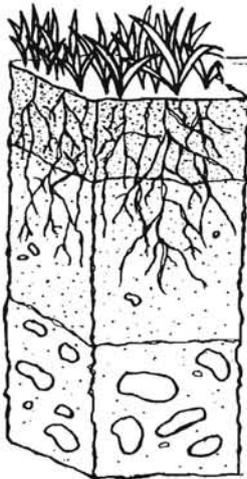
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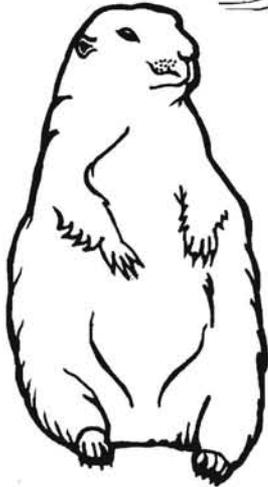
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# Preface

Nature offers many moods: the serenity of running water, the seasonal color change of leaves, the violence of a howling blizzard, the movement of animals in flight, the pastoral beauty of a landscape, the kaleidoscope of colors in a desert sunset. But as we enjoy the natural world, we don't often think of one very important part: the soil. Soil is the substance in which most of our food is grown or raised. Soil is also the mud that squishes under our shoes after a rainstorm, and the grit that grazes our faces as the wind whips across a dry landscape. Soil provides space for our buildings and communities, but also is the substance that muddies our rivers when we don't properly care for the land.

Soil results from a complex series of geological, human, and biological forces. It is a tangible and traceable

record of these forces. This record is illustrated by the color, feel, odor, and even the taste differences of the world's thousands of soils.

The Natural Resources Conservation Service (NRCS) has collaborated with the National Science Teachers Association (NSTA) on *Dig In! Hands-On Soil Investigations* for elementary science teachers and supervisors. The activities in *Dig In!*, designed for students in kindergarten through fourth grade, introduce soil's mysteries in an enjoyable and educational way.

As you use these activities, you and your students will gain a greater appreciation for the value of soil. Such an understanding is critical if today's students are to become informed decision-makers and conservers of our natural resources.

# Acknowledgments

**D**ig-In! Hands-On Soil Investigations is a co-publication of the Natural Resources Conservation Service (an agency of the U.S. Department of Agriculture) and the National Science Teachers Association.

This book was conceptualized by the former NRCS Educational Relations Staff and by Agri-Education, Stratford, Iowa, under contract with NRCS. Paul DuMont and Theodore Kupelian (Educational Relations Staff) and Thomas Levermann (NRCS) incorporated new ideas and product direction. Other former agency staff contributing to the initial development of *Dig-In!* include Hubert Kelly and Duane Bosworth. Lesson 9: Watching Worms was adapted from a *Science and Children* article by Lori Gibb (Noah Wallace School, Farmington, Connecticut). Sandra Laskey wrote and illustrated two special stories for teachers to read to students.

NRCS soil scientists, including Dr. Richard Arnold, Dr. Hari Eswaran, Dr. Sheryl Kunickis, and Soil Survey Division Director Horace Smith, reviewed various drafts of *Dig-In!* NRCS Earth Team volunteers contributed to the further development and refinement of *Dig-In!* Greg Donaldson developed and refined the initial publication design, and Barbara Levermann provided extensive proofreading and editorial review.

*Dig-In!* was thoroughly reviewed and tested by educators. In addition to the

numerous educators who advised NRCS during the book's development, the book was reviewed by Rhonda Bajalia (Crown Point Elementary School, Jacksonville, Florida), Betsy Benz (Wickliffe Elementary School, Wickliffe, Ohio), Dr. E. Barbara Klemm (Associate Professor of Education, University of Hawaii at Manoa), and David Brown (St. Peter School, Quincy, Illinois). Special thanks also go to Melody Orban (Elementary Science Resource Teacher, Kenosha Unified School District, Kenosha, Wisconsin) and the following teachers for testing these activities with their students: Kimberly George, Mary Pilot, and Steve Plato (Bain Elementary School, Kenosha, Wisconsin); Judith Herr (Grewenow Elementary School, Kenosha, Wisconsin); Corinne Nelson and Debbie Schuebel (Harvey Elementary School, Kenosha, Wisconsin); Kathy Leffler (Jefferson Elementary School, Kenosha, Wisconsin); and Gigi Bohm and Sharon Tilton (Union Grove Elementary School, Union Grove, Wisconsin).

The NRCS project manager for *Dig In! Hands-On Soil Investigations* was Thomas Levermann, Head of Education and Publications, Conservation Communications Staff. At NSTA, the project editor was Jessica Green. Also at NSTA, Linda Olliver designed the book and the cover, Tracey Shipley and Joanne Cunha created line art, Nguyet Tran did book layout, and Catherine Lorrain-Hale coordinated production and printing of the book.

# How to Use This Book

**T**hese activities are designed to heighten student awareness of the value of soil. The focus of information and activities should not be on getting the right answers, but on asking the right questions. All reasonable ideas given by students are acceptable.

## Concepts and Vocabulary

Significant words are italicized in the Teacher Background of each lesson and are also defined in the glossary (Appendix A). These key words allow classroom teachers to match the skill and instructional areas required by school boards with activities contained in each lesson. You will also find tables on the following pages correlating each lesson with other disciplines, the *National Science Education Standards*, and the *Benchmarks for Science Literacy*.

Adapt the teaching methods in each lesson to your classroom's individual needs. You might use vocabulary lists, word charts, and concept maps to help students relate ideas and understand key terms.

## Planning

Each lesson has a special emphasis and builds upon previous lessons, although each may be used separately. The lessons include background information and guidelines for

conducting the activities. Each lesson is made up of five short activities that correspond to the stages in a student's learning cycle. The *Dig In!* learning cycle is adapted from the 5 E instructional model (Trowbridge and Bybee 1995).

- 1** *Perception*: students discuss ideas
- 2** *Exploration*: students engage in hands-on investigations of concepts
- 3** *Application*: students communicate ideas and apply ideas to a new situation
- 4** *Evaluation*: students' knowledge is assessed
- 5** *Extensions* (optional): students expand their understanding of concepts

Each Learning Cycle activity requires approximately 30 minutes. The directions for planning and conducting activities include estimated times, but the actual time will vary depending on your pupils' age and abilities and on material availability. Make sure students have plenty of time to explore and experiment, especially during the Exploration and Application stages.

Students can work individually or in groups. Dividing your class into groups will reduce the amount of materials and preparation time needed, and may help students learn the concepts. When conducting activities in groups, remind the class that everybody has strengths and weaknesses and that each group

member should participate, cooperate, and contribute to the success of the group.

Think about ways to make the activities and learning fully accessible to all students, including those with special needs.

## Materials

The activities call for inexpensive, low-impact items such as plastic jars, lids, egg cartons, and rocks. Before introducing each lesson, ask students to bring materials from home and send a note to parents explaining why these items are needed. Use recycled products and reuse items as much as possible. The materials list in each lesson gives the items necessary for the first four activities of the Learning Cycle, but not for the optional Extensions at the end of each lesson.

Soil is required for Lessons 1, 2, 3, 6, 9, and 10. In some areas of the United States, soil use is restricted because of concern about transporting agricultural pests and invasive species into vulnerable ecological areas. Check local regulations concerning the use and transportation

of soil before you conduct these lessons. Ask the school custodian, a greenhouse or nursery, construction business, or a local NRCS or USDA Office for donations of or suggestions on how to obtain samples of silty, sandy, and clayey soil. In Lessons 1 and 2, your class will sample soil from the school yard. Before you start these lessons, secure permission from school administrators and custodial staff to take soil from the school grounds.

Do not substitute potting soil—because it has been sterilized, potting soil does not contain the items found in natural soil.

Only once, in Lesson 1, is it appropriate to use the word “dirt.” After that, the proper term is “soil.”

## Stories

Lessons 6 and 8 include stories to read to students as an optional Extension activity. The stories are preceded by suggestions for activities that will reinforce the concepts in the stories and the lessons.

# Maps for Learning

**W**hat should students learn? In what order? And how does each strand of knowledge connect to other vital threads? These are the tough questions every teacher faces, and the illustrations on the following pages are designed to help you answer them.

The following illustrations introduce a way of considering and organizing science content standards. The maps use the learning goals of the American Association for the Advancement of Science (AAAS)'s *Science for All Americans* and *Benchmarks for Science Literacy*. The maps are excerpted from *Atlas of Science Literacy*, copublished by AAAS and NSTA in a two-volume work (Volume I, AAAS 2001). The complete *Atlas* will contain nearly one hundred similar maps on the major elementary and secondary basic science topics: solar system, cells and organs, laws of motion, chemical reactions, evolution, and more.

## How to Use the *Atlas* Maps

*Atlas of Science Literacy* shows that understanding one goal contributes to the understanding of another. Each *Atlas* map is designed to help clarify the context of a science benchmark or standard: where it comes from, where it leads, and how it relates to other

standards. With the maps as guides, you can make sure your students have experience with the prerequisite learning, and you can draw students' attention to related content—getting their framework for learning ready!

The *Atlas* maps included in this book list the ideas relevant to students' understanding of three main topics: "Processes that Shape the Earth," "Flow of Matter in Ecosystems," and "Agricultural Technology" (see Figures i.1–i.3). These maps trace the ideal development of knowledge from kindergarten to eighth grade. Horizontal lines represent the grade-level appropriateness. Goals that deal with the same idea are organized into columns (called "strands") with more sophisticated goals above simpler ones, connected by arrows. The concept squares in the map that relate directly to *Dig In!* learning goals are shaded in gray. These are the concepts that you want your students to fully grasp. They underlie the Student Objectives presented at the beginning of each lesson.

The *Atlas* maps can help you connect your instruction to your state science standards. As of this writing, 49 of the 50 states in the US have developed their own standards, most modeled directly on the *Standards* or AAAS's

*Benchmarks.* The correlation between the *Standards* and *Benchmarks* in science content is nearly one hundred percent. So there is a unity of purpose and direction, if not quite a common language. Fortunately, the National Science Foundation, the Council of Chief State School Officers, and other groups have developed websites to guide educators in correlating these national standards with their state goals (for example, the ExplorAsource website at [www.explorasource.com/educator](http://www.explorasource.com/educator) gives these correlations). The websites of many state departments of education also provide these correlations.

## **Exploring the Atlas Maps**

Though the three excerpted maps in Figures i.1–i.3 represent many of the science learning goals for *Dig In!*, you will want to visit the AAAS Project 2061 website at [www.project2061.org](http://www.project2061.org) to download and explore other maps relevant to *Dig In!* lessons. The full *Atlas* maps also display strands of science learning for K–12; for reasons of space, the maps printed here only show K–8 science learning goals.

The maps suggest the progression of learning. A particular *Dig In!* lesson

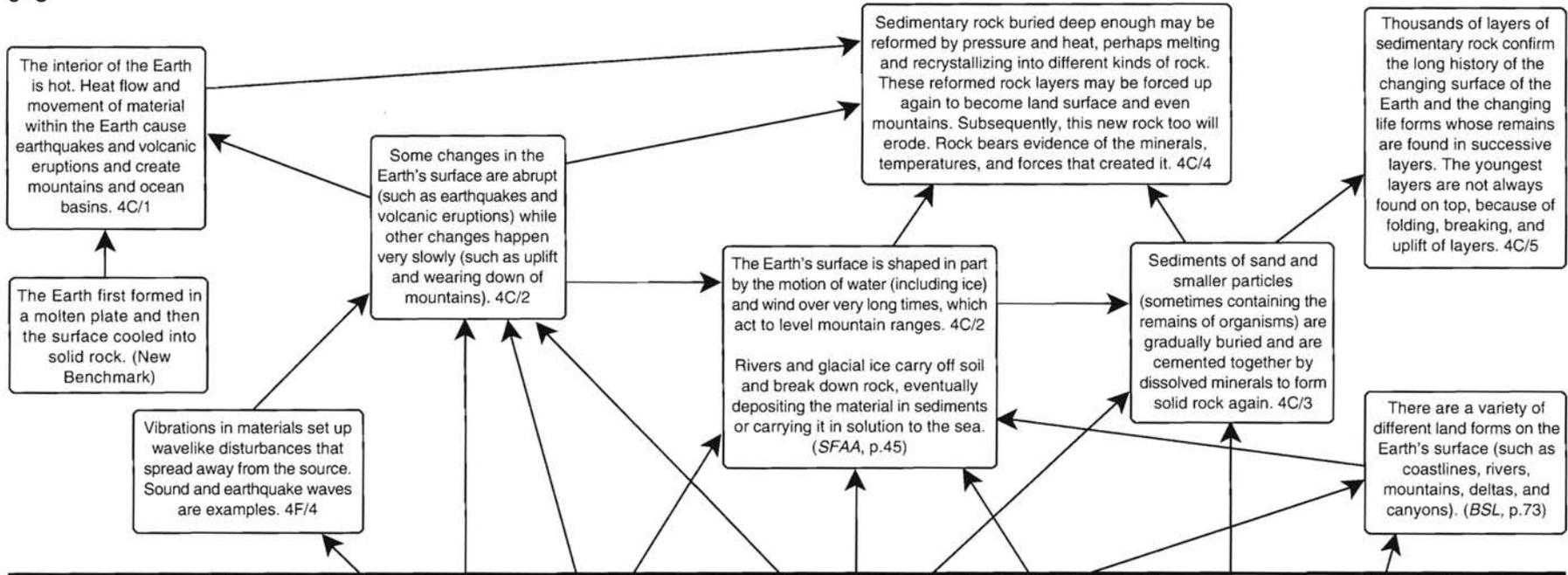
may not be sufficient for students to become proficient with some of the basic or extended ideas in the map strand; checking the progress of your students along the way will help you see how to adapt instruction. Lessons may also touch on concepts outside of what the various science standards consider essential for basic science literacy. Therefore, you may decide to focus activities to achieve your core learning goals.

In addition to using the maps to plan instruction, you may wish to annotate maps with common student misconceptions, or accurate conceptions you can invoke to dispel these misconceptions. Motivating questions that have worked for you, and phenomena that illustrate points, may also find a place on your annotated maps.

*Dig In!* activities are interdisciplinary, covering art, geography, language arts, math, and social studies as well as science. You can annotate the *Atlas* maps with opportunities to achieve learning goals for other disciplines, or use the map design to trace your lesson plan structure for learning goals in the other disciplines.

**Figure i.1. Atlas of Science Literacy map: Changes in the Earth's surface.**

6-8



3-5

K-2

Earthquakes and Volcanos strand

Rates of Change strand

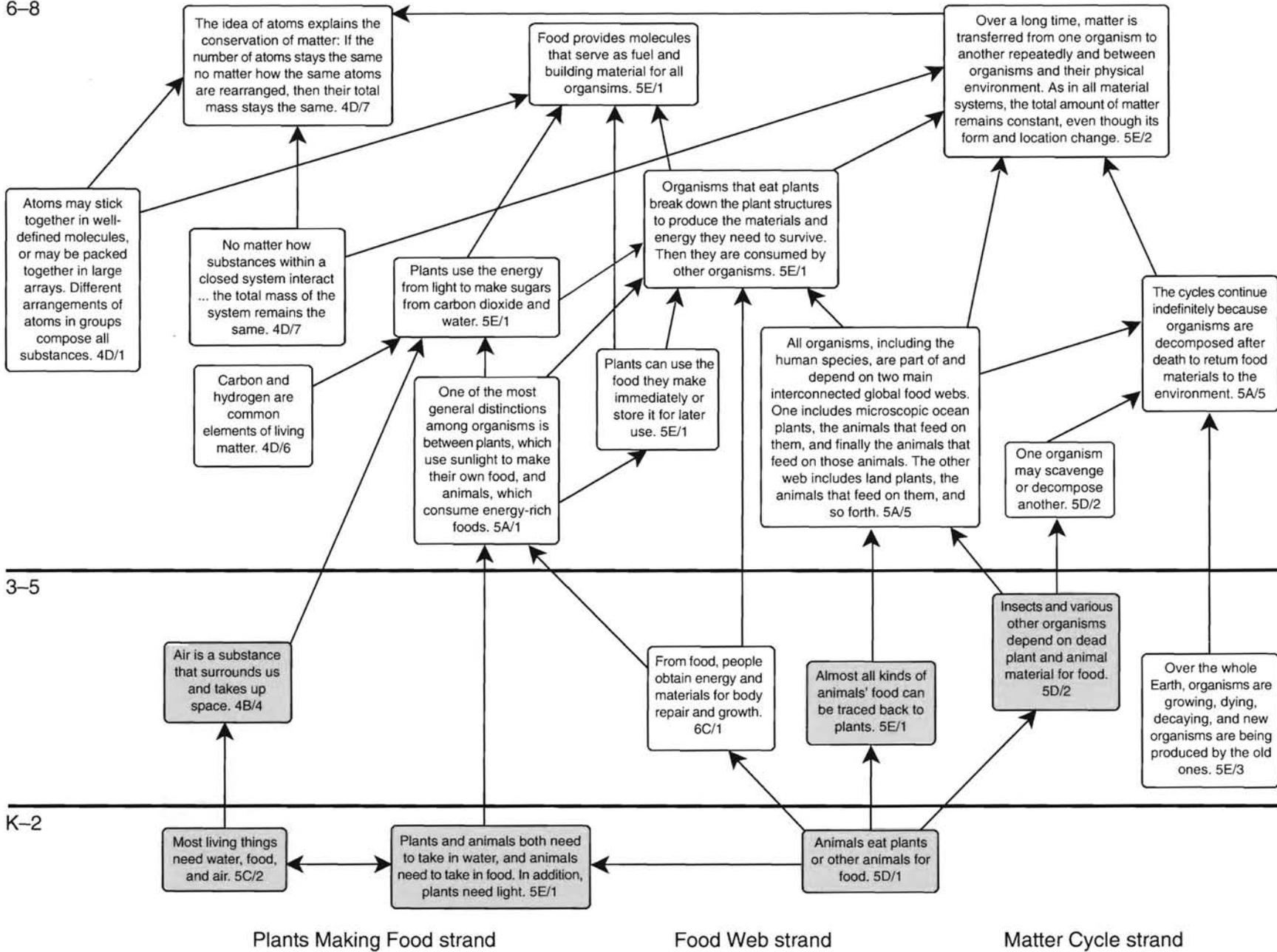
Weathering and Erosion strand

Rocks and Sediments strand

Map Key	
<b>BSL</b>	concept from <i>Benchmarks for Science Literacy</i> (AAAS 1993)
<b>code</b> (e.g., 4F/2)	chapter, section, and number of corresponding Benchmark goal
<b>SFAA</b>	concept from <i>Science for All Americans</i> (AAAS 1993)
<b>New Benchmark</b>	concept from a newly written benchmark
	concept covered in <i>Dig In!</i>

**Figure i.2. Atlas of Science Literacy map: Flow of matter in ecosystems.**

6-8

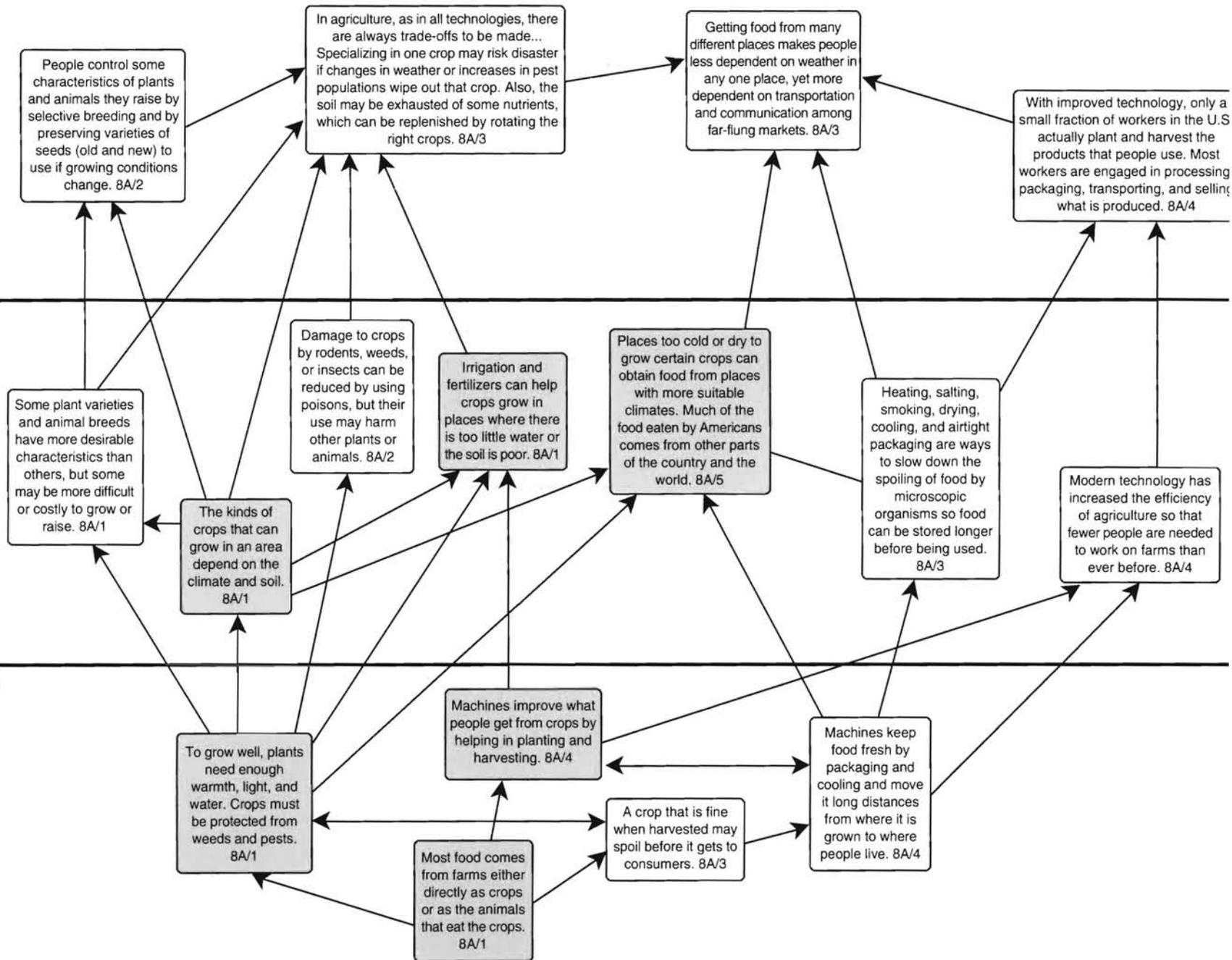


**Figure i.3. Atlas of Science Literacy map: Agricultural technology.**

6-8

3-5

K-2



Map Key	
<b>BSL</b>	concept from <i>Benchmarks for Science Literacy</i> (AAAS 1993)
<b>code (e.g., 4F/2)</b>	chapter, section, and number of corresponding <i>Benchmark</i> goal
<b>SFAA</b>	concept from <i>Science for All Americans</i> (AAAS 1993)
<b>New Benchmark</b>	concept from a newly written benchmark
	concept covered in <i>Dig In!</i>

Controlling Characteristics strand

Producing Food strand

Transporting Food strand

Effects on Society strand

# Lesson Assessment

Use the maps from *Atlas of Science Literacy* (Figures i.1–i.3) as an aid to your constructivist teaching methods. Allow students to recognize and integrate concepts—either never learned or incompletely remembered—into the big picture of why these concepts are useful to know.

Before you undertake any of the *Dig In!* activities, it is important to know whether your students have mastered the principles in the map that lead to their current grade level. You may, for example, be surprised to learn that some of your fourth-graders do not really understand that “Most food comes from farms either directly as crops or as the animals that eat the crops” (Benchmark 8A/1), a concept that, according to the *Atlas* map, should be mastered by grade two. Students may also have a mix of true and false understandings about what plants need in order to grow. It may be wise to ensure—perhaps by a class-developed concept map—that all students start *Dig In!* with the basic information needed to understand the concepts presented in these lessons.

The lessons in *Dig In!* use an inquiry approach to guide student understanding of the concept goals. Each lesson takes students through a learning cycle of making observations,

exploring, making predictions, and testing their conclusions. Throughout each lesson, guided discussion, plus verbal and written presentation methods for students, provide a record of thinking and learning—showing you and your students what they understand, what is still fuzzy or missing, and whether students can now use what they know. Use these methods as formative assessments to guide your plans for how to use the *Dig In!* activities.

Each activity ends with an Evaluation section to assess your students’ understanding of the concepts. The goal of any summative assessment is to determine whether students can apply their learning to new situations—to show you, and to show themselves, that they have a new tool for understanding. There are many ways to evaluate your students, and you should adapt your methods to the activity and to your class. For instance, Lesson 1 emphasizes ways to describe and characterize soil. An appropriate assessment method may be to have students draw the three types of soil and then fill in the blanks or use vocabulary words to label the drawings. Figure i.4 has an example of a rubric you might use to assess students for this lesson. You can adapt this rubric to match the Student Objectives of any of the lessons.

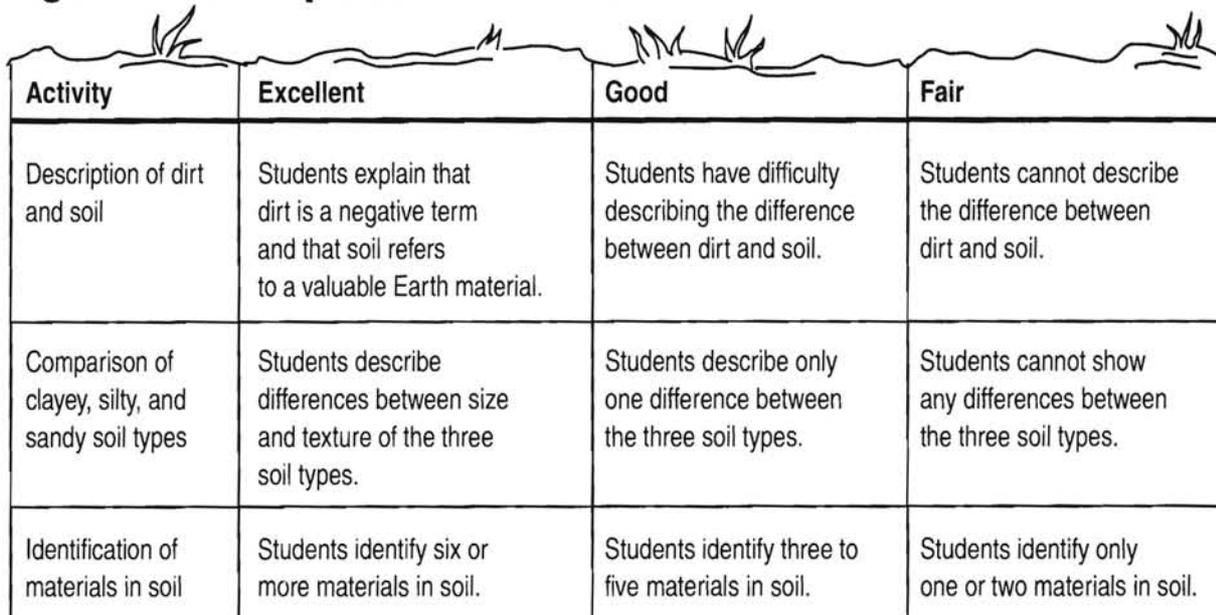
NSTA's *Science Educator's Guide to Assessment* has more guidelines on this topic (see the resources list in Appendix B).

## Extensions

Each lesson concludes with a set of extensions for ways students can

expand and test their learning. These extensions are applications of the concepts students have just investigated. You may wish to build a rubric for one or more of these extensions to share with your students, and use the extension as a summative assessment of your students' mastery of concepts.

**Figure i.4. A sample assessment rubric for Lesson 1.**



Activity	Excellent	Good	Fair
Description of dirt and soil	Students explain that dirt is a negative term and that soil refers to a valuable Earth material.	Students have difficulty describing the difference between dirt and soil.	Students cannot describe the difference between dirt and soil.
Comparison of clayey, silty, and sandy soil types	Students describe differences between size and texture of the three soil types.	Students describe only one difference between the three soil types.	Students cannot show any differences between the three soil types.
Identification of materials in soil	Students identify six or more materials in soil.	Students identify three to five materials in soil.	Students identify only one or two materials in soil.

# Interdisciplinary Correlations

The activities in *Dig In! Hands-On Soil Investigations* are designed for elementary science classes, and can also be used

to teach concepts in art, geography, language arts, mathematics, and social studies (see Figure i.5).

**Figure i.5. Subjects covered by *Dig In!***

		Art	Geography	Language Arts	Mathematics	Science	Social Studies
Section I	Lesson 1: Soil Searching	•		•		•	
	Lesson 2: Scenic Soil	•		•		•	
	Lesson 3: Soil Supreme	•		•		•	
Section II	Lesson 4: Lofty, Level, and Lumpy	•	•	•		•	•
	Lesson 5: Life on the Land	•	•	•		•	•
	Lesson 6: Plant a Plant	•		•	•	•	
Section III	Lesson 7: Animal Apartments	•		•		•	
	Lesson 8: Living Links	•		•		•	
	Lesson 9: Watching Worms	•		•		•	
Section IV	Lesson 10: Wind + Water = Waste	•		•	•	•	•
	Lesson 11: Soil Scientists	•		•		•	•
	Lesson 12: An Outdoor Learning Center	•		•	•	•	•

# Correlations with the *National Science Education Standards*

**D**ig In! is built upon the precepts of the *National Science Education Standards* for kindergarten to fourth grade. The science content standards outline what students should know, understand, and

be able to do in the natural sciences over the course of K-12 education. Figure i.6 on the next page shows the correlation between those content standards and the concepts addressed in *Dig In!*

**Figure i.6. Correlations with the *National Science Education Standards* for grades K–4.**

Content Standard	Topic	Section I			Section II			Section III			Section IV		
		Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6	Lesson 7	Lesson 8	Lesson 9	Lesson 10	Lesson 11	Lesson 12
(A) Science As Inquiry	Ask a question about objects, organisms, and events in the environment	•	•	•			•	•	•	•	•		•
	Plan and conduct a simple investigation						•			•	•		•
	Employ simple equipment and tools to gather data and extend the senses	•	•				•	•			•		•
	Use data to construct a reasonable explanation						•			•	•		•
	Communicate investigations and explanations	•	•	•	•		•	•	•	•	•		

**Figure i.6 continued**

Content Standard	Topic	Section I			Section II			Section III			Section IV		
		Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6	Lesson 7	Lesson 8	Lesson 9	Lesson 10	Lesson 11	Lesson 12
(C) Life Science	The characteristics of organisms				.		.	.	.	.			.
	Organisms and their environment				.	.		.	.	.			.
(D) Earth and Space Science	Properties of Earth materials	.	.	.	.		.	.		.	.	.	.
	Changes in the Earth and sky		.							.	.	.	.
(F) Science in Personal and Social Perspectives	Types of resources					.	.	.	.	.	.	.	.
	Changes in environments				.	.		.	.	.	.	.	.
	Science and technology in local challenges				.	.					.	.	
(G) History and Nature of Science	Science as a human endeavor					.						.	.

# sciLINKS

**D**ig In! Hands-On Soil Investigations brings you sciLINKS, a creative project from NSTA that blends the best of the two main educational “drivers”—textbooks and telecommunications—into a dynamic new educational tool for all children, their parents, and their teachers. This sciLINKS effort links specific textbook and supplemental resource locations with instructionally rich Internet resources. As you and your students use sciLINKS, you will find rich new pathways for learners, new opportunities for professional growth among teachers, and new modes of engagement for parents.

In this sciLINKed text, you will find an icon near several of the concepts you are studying. Under it, you will find the sciLINKS URL ([www.sciLINKS.org](http://www.sciLINKS.org)) and a code. Go to the sciLINKS Web site, sign in, type the code from your text, and you will receive a list of URLs that are selected by science educators. Sites are chosen for accurate and age-appropriate content and good pedagogy. The underlying database changes constantly, eliminating dead or revised sites or simply replacing them with better selections. The ink may dry on the page, but the science it describes will always be fresh.

sciLINKS also ensures that the online content that teachers count on remains available for the life of this text. The sciLINKS search team regularly reviews the materials to which *Dig In!* points—revising the URLs as needed or replacing

webpages that have disappeared with new pages. When you send your students to sciLINKS to use a code from this text, you can always count on good content being available.

The site selection process involves four review stages:

- 1 A cadre of undergraduate science education majors searches the World Wide Web for interesting science resources. The undergraduates submit about 500 sites a week for consideration.
- 2 Packets of these webpages are organized and sent to teacher-web-watchers with expertise in given fields and grade levels. The teacher-web-watchers can also submit webpages they have found on their own. The teachers pick the jewels from this selection and correlate them to the *National Science Education Standards*. These pages are submitted to the sciLINKS database.
- 3 Scientists review these correlated sites for accuracy.
- 4 NSTA staff approves the webpages and edits the information for accuracy and consistent style.

Who pays for sciLINKS? sciLINKS is a free service for textbook and supplemental resource users, but obviously, someone must pay for it. Participating publishers pay a fee to NSTA for each book that contains sciLINKS. The program is also supported by a grant from the National Aeronautics and Space Administration.

