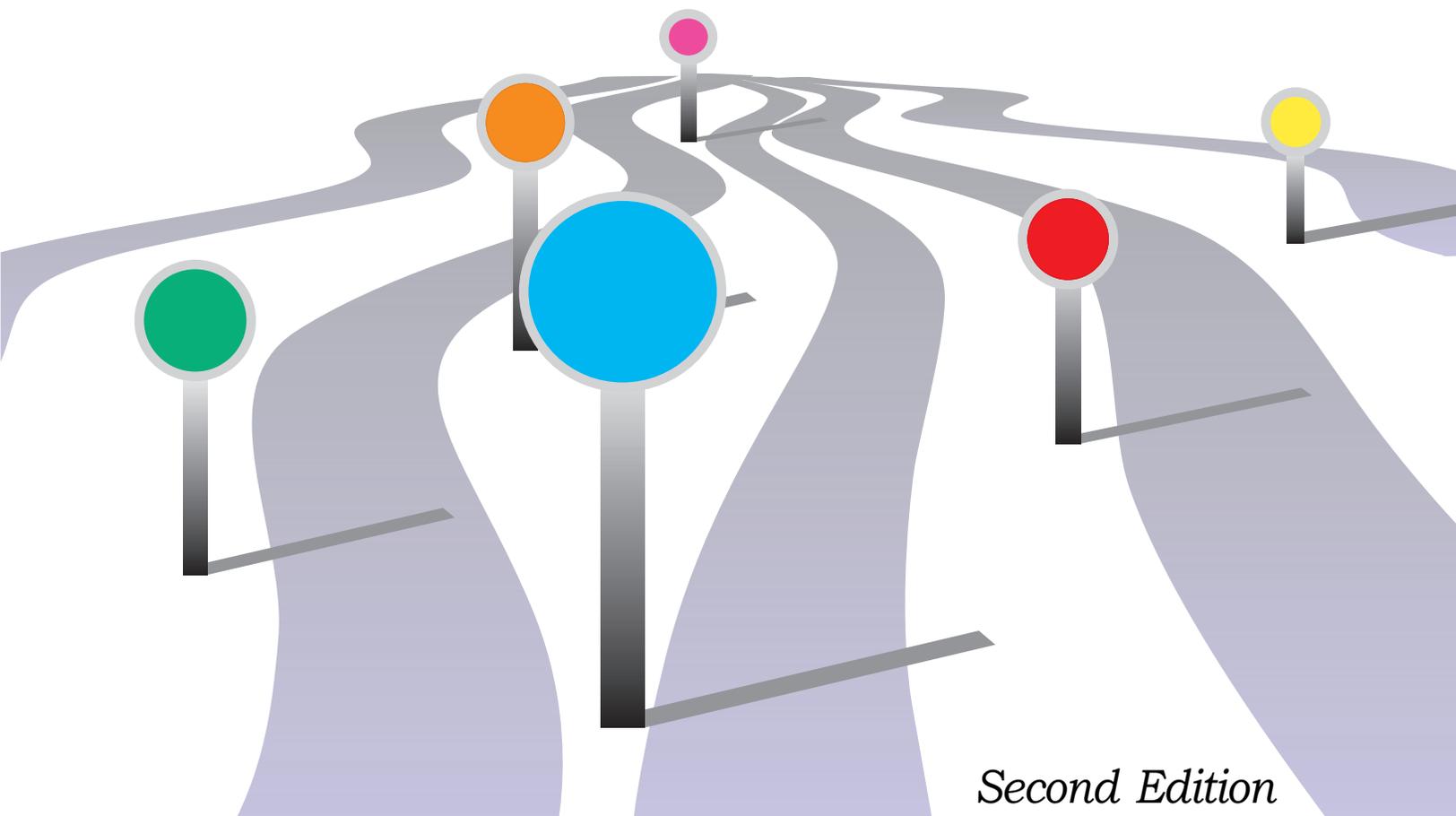


NSTA PATHWAYS

To the Science Standards

Elementary School Edition

Editor
Lawrence F. Lowery



Second Edition

Guidelines for Moving the Vision into Practice



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NSTA Pathways to the Science Standards:
Guidelines for Moving the Vision into Practice
ELEMENTARY SCHOOL EDITION, Second Edition

Editor: Lawrence F. Lowery

Contributing Editors: Juliana Texley, Sheila Marshall, Ann Wild

Contributors: Charles Barman, Karen Bishop, Catherine Blair, Pat Bowers, Mike DiSpezio, Sheila Dunston, Jerry Foster, Carol Glass, Almata Hall, Roger Johnson, Tricia Kerr, Mozell Lang, JoAnne de Maria, Joan Braunagel McShane, Suzanne Moore, Norma Nealy, Karen Ostlund, Michael Padilla, Larry Schafer, Juliana Texley, Gerry Wheeler, Bonita Talbot-Wiley, Deborah Wilson, and the NSTA Committee on Preschool-Elementary Science Teaching

Editor of the Facilities Section: Suzanne Lieblich

Contributors to the Facilities Section: James Biehle, LaMoine Motz, Victor Showalter, Sandra West,

NSTA Project Manager: Sheila Marshall

NSTA Editorial Assistant: Christopher Hampton

NSTA project editors for the second edition: Jessica Green and Erin Miller

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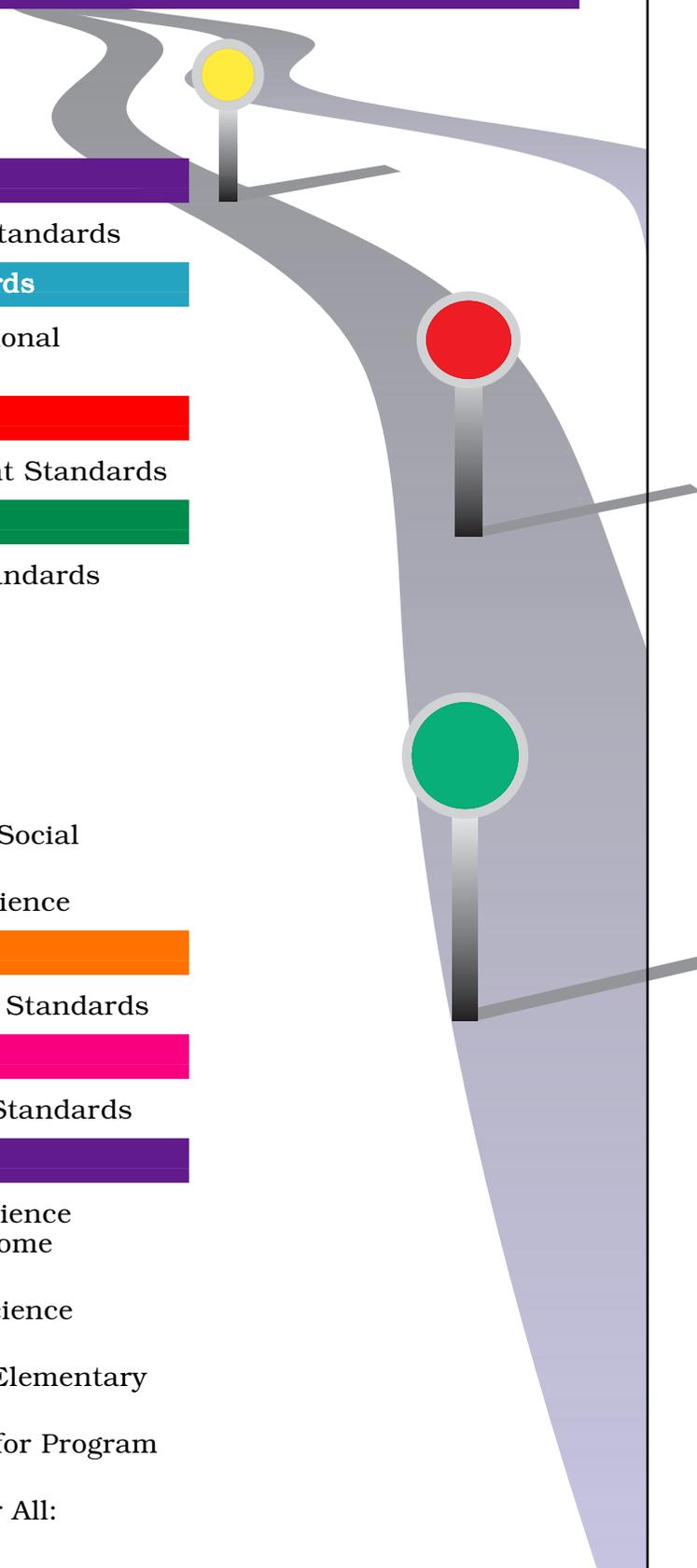
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About sciLINKs

NSTA Pathways to the Science Standards brings you sciLINKS, a new project that blends the two main delivery systems for curriculum—books and telecommunications—into a dynamic new educational tool for children, their parents, and their teachers. sciLINKS links specific science content with instructionally-rich Internet resources. sciLINKS represents an enormous opportunity to create 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—like the one on this page—that illustrates the concepts in the content standards for grades K–6. Under the icon, you will find the sciLINKS URL (<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.

Web 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 teachers count on remains available for the life of this text. The sciLINKS search team regularly reviews the materials to which this text points—revising the URLs as needed or replacing Web pages 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 selection process involves four review stages:

1. A cadre of undergraduate science education majors searches the Web for interesting science resources. The undergraduates submit about 500 sites a week for consideration.
2. Packets of these Web pages are organized and sent to teacher-Web-watchers with expertise in given fields and grade levels. The teacher-Web-watchers can also submit Web pages that 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 approve the Web pages and edit the information provided for accuracy and consistent style.

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 (NASA).



EARTH AND SPACE SCIENCE

K-6

INTRODUCTION

From earliest times, humans have looked at the Earth and sky with wonder, trying to find explanations for what they saw. Today, we have learned more about our solar system from our own experiences, and from the great wealth of information available to us. Together, these two ways of learning help us to understand the world around us.



We know that young children are naturally curious about their world and the living organisms within it. Non living materials like rocks, rivers, stars, and snow also offer opportunities for observation by which students develop an early understanding of Earth and the solar system.

In grades K-4, student learning about Earth and sky occurs primarily by making observations as they explore, collect, describe, and record information. Students investigate the properties of water, rocks, minerals, and soil. We guide them in observing natural changes of all kinds, including cyclical changes, such as the movement of the Sun and moon, and variable changes, like the weather.

The Earth and Space Science Standard for levels 5-8 fo-

cus on the structure of the Earth system, Earth's history, and Earth in the solar system. Students' increased experience and sophistication allow us to introduce the concept of systems, including Earth's four major interacting systems: the geosphere, hydrosphere, atmosphere, and biosphere. The students work with models to explain Earth and solar system phenomena, such as the rock cycle and the water cycle.

Students investigate the interactions between Earth materials to learn about weathering, erosion, deposition and the landforms that result from such processes. A number of the concepts in this Standard, such as the explanations of moving lithospheric plates and cloud formation, are intended for grades 7 and 8.

CONTENT STANDARD D

D **K-4** —————
 * **As a result of their activities in grades K-4, all students should develop an understanding of**

- **Properties of earth materials**
- Objects in the sky
- Changes in earth and sky

5-8 —————
As a result of their activities in grades 5-8, all students should develop an understanding of

- **Structure of the earth system**
- Earth's history
- Earth in the solar system

* Bolded statements are discussed in the text

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EARTH AND SPACE SCIENCE

K-2

CONTENT STANDARD D K-4

Properties of earth materials

Nature of the Learner

Most students at this level are able to communicate their observations and comparisons to others. They make simple comparisons between objects. With guidance, they will be able to group and order objects on the basis of a single characteristic.

Get Ready for Science

Earth materials are rocks, soils, fossil fuels, water, and the gases in Earth's atmosphere. Earth's surface also includes living organisms, but they are not considered Earth materials.

The various Earth materials have properties that make them useful to us in different ways. Soils vary, but



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are usually able to support plants. Earth materials are used for building, as sources of fuel, and for growing plants.



Get Set for Instruction

We need to give our students a variety of concrete experiences that enable them to learn about the properties of Earth materials through observation. Here are some examples:

- When students observe and describe the properties of rocks, they will begin to see that some are made up of a single substance, but most are made up of several substances (minerals).
- By collecting rocks and observing vegetation, they will become aware that soil varies in color, texture, and fertility from place to place.
- By visiting an appropriate outdoor study site on a regular basis, students will

come to understand that Earth's surface is constantly changing.

- Show students areas where erosion is occurring.

Assessment

Activities such as grouping and sequentially ordering Earth materials give us opportunities to assess students' skills and understanding of concepts. For example:

- Ask students to group a variety of rocks according to one of their properties, such as color, pattern (plain or striated), buoyancy, or layering.
- Challenge students to find out which type of soil, clay, sand, or humus,
 - a) allows the most water to pass through it
 - b) filters water most effectively
 - c) is best for growing bean plants
 - d) crumbles most easily when dry.

Primary Elementary, Grades K-2

EARTH AND SPACE SCIENCE

K-2

CONTENT STANDARD D K-4

Properties of earth materials



Go! An Example of a Classroom in Action

In Jim Murphy's class, students have been studying the physical properties of Earth materials. Over the past few weeks, they have used hand lenses to gain a close-up view of small rocks, soils, and grains of sand collected from a local beach. Students discussed the similarities and differences between these materials. Their observations sparked various questions. Mr. Murphy asks:

- How do particles of sand and dirt differ from each other?
- Which particles would make the dirt better for growing plants?
- Can dirt turn into rocks? Can rocks turn into dirt?
- Are all grains of sand the same size?

Mr. Murphy selects one of the questions and has his students discuss how a scientist might approach finding the answer.

Mr. Murphy selects a question about the size of the grains of sand because this inquiry

can be completed within a reasonable time-frame and requires the use of scientific tools (sieves). He also likes the fact that his students can make use of the sand samples they had collected during the warmer months.

He demonstrates the use of a set of sieves and allows the students to examine them. Then he asks them to think of questions that might be answered by using the sieves. He accepts all reasonable suggestions, such as:

- Are dirt particles bigger than sand particles?
- Do different beaches have sand of different sizes?

He then supplies student groups with sets of sieves and challenges them to sort the grains of sand. He offers sand from two different sources. As the students will discover, one sample is mostly coarse grained; the other, mostly fine grained.

When the students have completed their inquiry, Mr.

Murphy asks the groups to share their findings. He challenges them to think of different ways to describe their results. One group displays its data as a pictograph. Another group uses a bar graph. A third presents its findings in cartoon frames.

Mr. Murphy encourages the students to venture beyond concrete observations and draw inferences from their observations.

He asks his students to think of additional questions that would form the basis for particle sorting, such as:

- Are some particles magnetic?
- Do any particles float?
- Will some particles react with vinegar?

Experiences like this one, driven by students' questions, have proved a powerful tool for meeting the goals that Mr. Murphy had set at the beginning of the year.

EARTH AND SPACE SCIENCE

CONTENT STANDARD D K-4

3-4

Objects in the sky

Nature of the Learner

Most middle elementary students are able to make and record sequential observations and identify simple patterns. With guidance from their teacher, they are able to observe cyclic changes (such as the seasons and the phases of the Moon).

Preparing for Science

Objects in the sky show patterns of movement. The Sun appears to move across the sky in the same way every day, but its path changes slowly over the seasons. The Moon moves across the sky much in the way the Sun does, but its shape seems to change from day to day in a cycle that lasts about a month.

Weather is also a sky phenomenon, varying from day to day and changing over the seasons. Weather can be described quantitatively through temperature, wind direction and speed, and amount of precipitation. An analysis of various measurements, together with careful observations of patterns, makes weather predictions possible

Nature of Instruction

By observing the day and night sky on a regular basis at dif-

ferent times, students will learn to identify cyclic change and to look for patterns. Involve students in some of the following activities:

- Each evening, students draw the Moon's shape on a calendar, note when it is visible (day/night), and keep a log of the Moon's color for a period of time. Seeing both the Sun and the Moon in the sky on the same day helps to dispel any notion that one substitutes for the other.
- Students will discover patterns of weather changes during the year by keeping a journal in which they draw daily weather pictures or by creating simple charts and graphs from the data they collect.

Assessment

When assessing what students know about objects in the sky, we stress the skills students have acquired in observing and describing, and how well they base their ex-



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planations on their observations.

- Arranging out-of-sequence images puts to good use the middle elementary students' abilities to place objects in logical order. These images may include the phases of the Moon, satellite images of terrestrial weather patterns and seasonal changes, and changes in living organisms.
- Students keep a log that reflects some sequential observations. This includes observations of the phases of the Moon, temperature changes, wind direction, amount of precipitation, and other planetary events. If students track the data for an extended period, the log may be useful to them in uncovering patterns and cycles based on observations.
- Students use weather data to make their own weather predictions. With temperature, humidity, sky cover, and wind direction, they will be able to make tentative forecasts.
- Students interpret information from the weather page in *USA TODAY*.

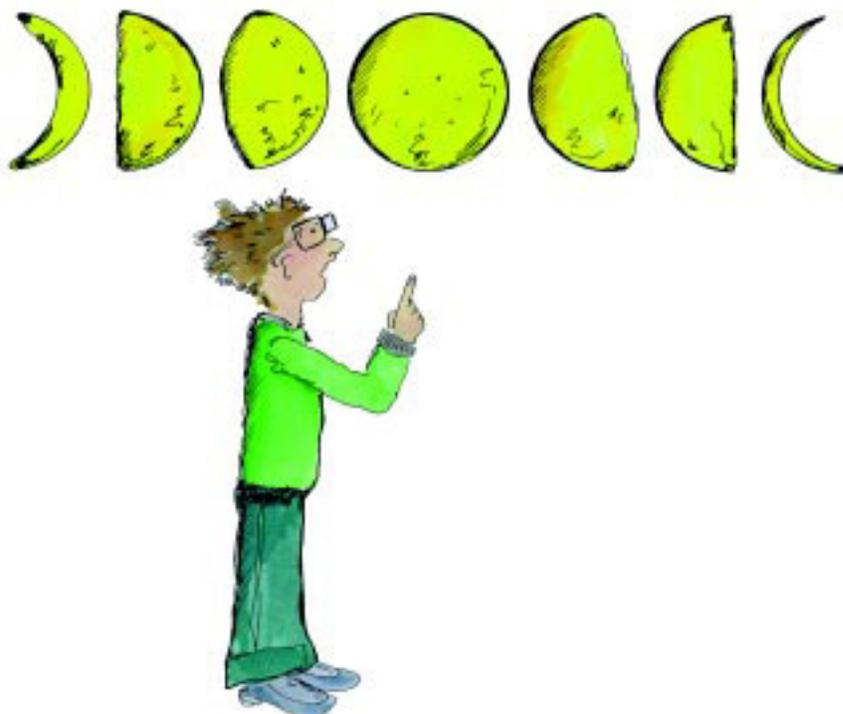
Middle Elementary, Grades 3-4

EARTH AND SPACE SCIENCE

CONTENT STANDARD D K-4

3-4

Objects in the sky



An Example of a Classroom in Action

Shaun Brown finds that lessons are most successful when she encourages her students to construct knowledge for themselves. Today, her class is learning about the phases of the Moon and attempting to develop explanations for them.

The students have been observing the Moon each night for the past two months and drawing pictures of what they have seen. Ms. Brown holds up

some of the pictures of the different phases of the Moon.

Ms. Brown then distributes calendar pages and has the students place their pictures on the calendar.

The students continue to gather Moon data for another month, adding their own observations to the calendar pages. When they have collected several months' worth of data, Ms. Brown challenges them with

the following questions:

- Does the full Moon appear on the same date each month? Is there a pattern?
- How many days are there between each half Moon and the next half Moon? Between each first-quarter Moon and the next first-quarter Moon?
- Can you uncover a pattern in the appearance of the half Moon or first-quarter Moon? Is it different from a full-Moon pattern?

EARTH AND SPACE SCIENCE

5-6

CONTENT STANDARD D 5-8

Structure of the earth system

Nature of the Learner

Most upper elementary students understand Earth's shape and its position in the solar system. They continue to improve at sequencing events. They begin to understand dynamic processes and the interaction of several components.

Preparing for Science

Earth is made up of several layers, each with its own composition and properties. The **lithosphere** includes the **crust** and part of the **upper mantle** and is broken into large sections known as **plates**. These float on the molten rock of the upper mantle which pushes and pulls the plates, causing them to collide, producing earthquakes, volcanoes and mountains. The next deepest layer is the **lower mantle** which surrounds Earth's **core**.

Surface features are worn down by **weathering**. Soil, sand, and small rocks, created by weathering are transported by wind and water. This is called **erosion**. Weathered and eroded rocks produce sediments that are gradually buried, compacted, and subjected to great pressure and heat. Over long periods of time these changed sediments form new rock which may be raised back to the surface and eroded again. This process is called the **rock cycle**.

Another cycle of change is known as the **water cycle**. Surface water evaporates as water vapor. When this invisible vapor cools, it condenses as liquid water. Clouds are composed of water that has condensed on very small particles of dust. When enough water condenses, the droplets fall to Earth as precipitation.

Water flows both above and below ground, and as it moves, it seeps into the soil and dissolves and transports substances. The water collects as groundwater that discharges into bodies of water like streams, rivers, and lakes. Eventually, the water runs into oceans and some of it evaporates, leaving behind the materials that had been dissolved in, it such as salt.

Weather and climate are strongly affected by water. On Earth's surface, the ability of water to hold large amounts of heat moderates temperatures. In the atmosphere, the upper surfaces of clouds reflect sunlight back into space, while the lower surfaces reflect back to Earth the heat that has radiated up from Earth's surface.

Earth's atmosphere is a mixture of different gases, including nitrogen, oxygen, carbon dioxide, and water vapor. The atmosphere has changed over Earth's history, largely because of the actions of living organisms.



Nature of Instruction

Most Earth-shaping events occur on such a large scale and in such inaccessible places that it is rarely possible for our students to experience them directly. Generally we use models—small, simplified representations of the large-scale objects and events—to help students understand the larger processes.

Assessment

Student understanding is measured by traditional and alternate assessment techniques, such as:

- Providing construction materials and asking the students to make models representing the structural aspects of Earth's systems. Include cross-sections of Earth, scale models of land forms, and maps of plate boundaries.
- Giving the students descriptions and photographs of land forms and asking them to describe the geologic processes responsible for forming these features.
- Asking students to make a chart illustrating the rock cycle, attaching samples of appropriate rocks.
- Having students construct a model of the water cycle that shows evaporation and condensation. Students should identify and describe each process.

Upper Elementary, Grades 5-6

EARTH AND SPACE SCIENCE**5-6****CONTENT STANDARD D 5-8****Structure of the earth system**

An Example of a Classroom in Action

Maria Cantata's class is working with small models, similar to stream tables, to learn about how some landforms are created.

Because her students are not yet familiar with stream tables, Ms. Cantata first introduces some procedures for preparing and using small models. The students learn that they must have a container for collecting runoff water and newspapers for absorbing spillage. Ms. Cantata tells students to think about how to prepare the Earth materials, position the water source, and so on.

As a preliminary activity, the students work, in groups, running water for a specified length of time through sand, soil, and gravel and observing the results. Ms. Cantata asks the students to discuss and compare their results, using graphs and drawings.

Next, Ms. Cantata involves students in an open-ended investigation in which they generate questions and formulate hypotheses. She provides the materials that students will need to generate evidence that may or may not support their ideas.

The students' questions suggest various inquiry possibilities, such as:

- Does sand erode as easily as gravel?
- How does the rate of water flow affect erosion?
- Will the slope of the table affect erosion?

As the students pose questions, Ms. Cantata writes them on a chart and asks the students to suggest ways they could answer them using the stream table or their models. As the students design their investigations, Ms. Cantata facilitates their thinking with questions such as:

- Which factors will you vary in your study? Which will you keep the same?
- How can you be sure that the rate of water flow is even and constant?
- How will you measure erosion?
- How might varying more than one factor affect your conclusions?



Before the groups proceed with their investigations using the small stream table or their table models, Ms. Cantata reviews their plans. If a group's design is not appropriate, she encourages the students to rethink it. Eventually, all of the groups come up with workable designs.

After several days, when the data have been collected and analyzed, the students report their results. Ms. Cantata encourages them to use visual aids to support their analyses. One group videotapes the erosion under study.

EARTH AND SPACE SCIENCE

K-6

CONTENT STANDARD D

PROGRAMS FOR ELEMENTARY SCIENCE

PRIMARY ELEMENTARY - GRADES K-2

Properties of earth materials

Full Option Science System (FOSS)

Pebbles, Sand, and Silt Module

Introduces primary-level students to basic observable/measurable properties of Earth materials.

Science and Technology for Children (STC)

Soil Unit

Introduces students to the properties of soils and the importance of soil to plant growth.

Changes in the earth and sky

Full Option Science System (FOSS)

Air and Weather Module

Introduces students to weather characteristics and some aspects related to changes of state.

Science and Technology for Children (STC)

Weather Unit

Students are introduced to weather phenomena and how they affect their everyday lives.

MIDDLE ELEMENTARY - GRADES 3-4

Properties of earth materials

Full Option Science System (FOSS)

Earth Materials Module

Introduces students to the concepts of rocks

and minerals. Composition and decomposition and simple tests are introduced.

Science and Technology for Children (STC)

Rocks and Minerals Unit

Students make observations and descriptions of rocks, noticing similarities and differences.

UPPER ELEMENTARY - GRADES 5-6

Structure of the earth's system

Full Option Science System (FOSS)

Landforms Module

Introduces students to erosion and deposition. Includes 3-D forms, topographic map making and interpretation.

Great Explorations in Math and Science (GEMS)

River Cutters Unit

The concepts of erosion, pollution, and human manipulation of rivers are introduced.

Earth and the solar system

Great Explorations in Math and Science (GEMS)

Earth, Moon, and Stars Unit

Students learn astronomy through the study of the Earth, moon, and stars.

See appendix D for addresses

EARTH AND SPACE SCIENCE

K-6

CONTENT STANDARD D

OTHER TOPICS COVERED BY STANDARD D

Changes in Earth and sky for levels K-4, and *Earth's history* and *Earth in the solar system* for levels 5-8 have not been illustrated. The following resources contain information and activities that cover these topics.



Topic: the planets
Go to: <http://www.scilinks.org/>
Code: PAE09

Topic: Earth's structure
Go to: <http://www.scilinks.org/>
Code: PAE010

RESOURCES FOR THE ROAD

Banks, Dale A. (1994, January). Earth, Sun, and Moon: A Moving Experience. *Science Scope*, 17 (4), 36-41.

Bellipanni, Lawrence J., and Hazen, Neal. (1994, February). A Wave Tank for Elementary Science. *Science and Children*, 31 (5), 23-25.

Brendzel, Sharon. (1994, April). Schoolyard Erosion and Terrain Studies. *Science Scope*, 17 (7), 36-38.

Czerniak, Charlene M. (1993, October). The Jurassic Spark. *Science and Children*, 31 (2), 19-22.

Fowler, Betty. (1994, September). More "Space" in the Classroom. *Science and Children*, 32 (1), 40-41, 55.

Hewitt, Patricia, and Odell, Michael, and Worch, Eric. (1995, November/December). Models Make it Better. *Science Scope*, 19 (3), 26-29.

Lowder, Connie C. (1993, November/December). Spelunking in the Classroom. *Science and Children*, 31 (3), 19-22.

Mayshark, Robin. (1992, September). Groundwater in a Fish Tank. *Science Scope*, 16 (1), 50-52.

Moore, G. Robert. (1994, November/December). Revisiting Science Concepts. *Science and Children*, 32 (3), 31-32, 60.

Pinkham, Chester A., and Barrett, Kristin Burrows.

(1992, September). Measuring Relative Humidity. *Science and Children*, 30 (1), 23-27.

Seagar, Douglas B. (1993, November/December). Where in the World? *Science Scope*, 17 (3), 14-18.

Whitney, David E. (1995, February). The Case of the Mislplaced Planets. *Science and Children*, 32 (5), 12-14, 46.

Wright, Rita F. (1993, January). How High Is Your House? *Science Scope*, 16 (4), 16-19.

The full text of most of these resources is available on NSTA's supplementary *Resources for the Road* CD-ROM.