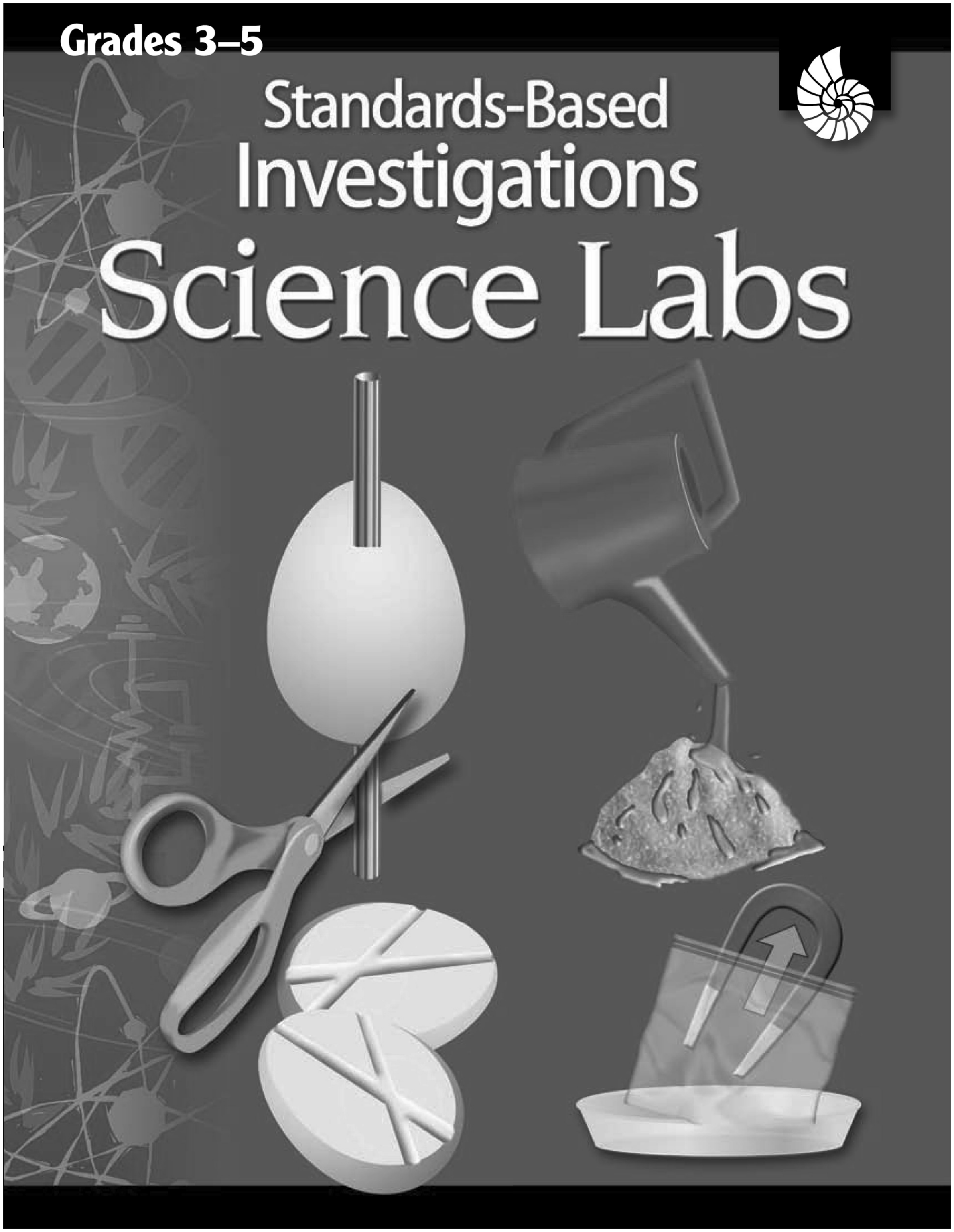

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SHELL EDUCATION

Table of Contents

Table of Contents *(cont.)*

Introduction and Research Base

Why a Focus on Science?

Over three decades ago, the American Association for the Advancement of Science began a three-phase project to develop and promote science literacy: Project 2061. The project was established with the understanding that more is not effective (1989, p. 4).

Inquiry-Based Learning

As Project 2061 began, researchers questioned the appropriateness and effectiveness of science textbooks and methods of instruction. Since textbook instruction puts more emphasis on learning correct answers and less on exploration, collaboration, and inquiry, the Association asserts that this manner of instruction actually "impedes progress toward scientific literacy" (1989, p. 14).

This same concern resurfaced over a decade later by Daniels and Zemelman (2004) who call textbooks "unfriendly." When most adults are choosing literature, they do not pick up their son's or daughter's science textbook. Daniels and Zemelman assert that today's textbooks are best used as reference books when students need large amounts of information on a particular topic within a subject area. Instead, they recommend the use of "authentic" sources.

Project 2061 recommends pedagogical practices where the learning of science is as much about the process as the result or outcome (1989, p. 147). Following the nature of scientific inquiry, students ask questions and are actively engaged in the learning process. They collect data and are encouraged to work within teams of their peers to investigate the unknown. This method of process learning refocuses the students' learning from knowledge and comprehension to application and analysis. Students may also formulate opinions (synthesis and evaluation) and determine whether their processes were effective or needed revision (evaluation).

The National Science Education Standards view inquiry as "central to science learning" (p. 2 of Overview). In this way, students may develop their understanding of science concepts by combining knowledge with reasoning and thinking skills. Kreuger and Sutton (2001) also report an increase in students' comprehension of text when knowledge learning is coupled with hands-on science activities (p. 52).

Values, Attitudes, and Skills

Scientists work under a distinctive set of values. Therefore, according to the American Association for the Advancement of Science, science education should do the same (1989, p. 133). Students whose learning includes data, a testable hypothesis, and predictability in science will share in the values of the scientists they study. Additionally, "science education is in a particularly strong position to foster three [human] attitudes and values: curiosity, openness to new ideas, and skepticism" (1989, p. 134). Science Labs addresses each of these recommendations by engaging students in thought-provoking, open-ended discussions and projects.

Within the recommendations of skills needed for scientific literacy, the American Association for the Advancement of Science suggests attention to computation, manipulation and observation, communication, and critical response. These skills are best learned through the process of learning, rather than in the knowledge itself (1989, p. 135).

Geology

This chapter provides activities that address McREL Science Standard 2.

Student understands Earth's composition and structure.

Knows how features on the Earth's surface are constantly changed by a combination of slow and rapid processes (e.g., slow processes, such as weathering, erosion, transport, and deposition of sediment caused by waves, wind, water, and ice; rapid processes, such as landslides, volcanic eruptions, and earthquakes)	*How Does Erosion Work?* (page 28) *What Happens to Frozen Clay?* (page 30) *How Do Stalactites and Stalagmites Form?* (see Teacher CD)
Knows that smaller rocks come from the breakage and weathering of larger rocks and bedrock	*What Is Inside Rocks?* (page 32) *How Are Sedimentary Rocks Formed?* (see Teacher CD)
Knows that rock is composed of different combinations of minerals	*What Happens to Chalk in Vinegar?* (page 34) *How Are Metamorphic Rocks Formed?* (see Teacher CD)
Knows the composition and properties of soils (e.g., components of soil such as weathered rock, living organisms, products of plants and animals; properties of soil such as color, texture, capacity to retain water, ability to support plant growth)	*What Is Soil Made Of?* (page 36) *What Are Different Soils Made Of?* (page 38) *Does Detergent Destroy Dirt?* (page 40) *Can I Take Soil Apart?* (page 42)
Knows that fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time	*How Are Fossils Made?* (page 115) *What Is Amber?* (page 117)

How to Teach Geology

Is Soil Made from Dinosaur Droppings?

We live on a rocky planet. Wherever we are, even in the middle of the ocean, there are rocks beneath our feet. These rocks were formed as Earth began to cool.

That cooling process is far from over. Under the hard, cold crust of Earth, the mantle and core of the planet are still intensely hot. They are so hot that molten rock periodically bursts through the crust as volcanoes.

Much of the rock on Earth's surface was formed from this original material, the so-called igneous rocks. But some have been eroded, transported, and laid down in layers of sediment (sedimentary rocks). Some of these have been subjected to intense heat and pressure and have changed or metamorphosed (metamorphic rocks).

Rocks are constantly being broken down. The final product of this breakdown is soil or "earth." Unlike the student who guessed that earth was made of dinosaur droppings, we know that soil is a rich, complex material.

Beneath Our Feet

Earth is like a giant soft-boiled egg. Earth's core—the yolk of the egg—is incredibly hot and liquid. Earth's mantle—the white of the egg—surrounds it and is also hot and liquid. It breaks out in places as volcanoes.

Earth's crust—the shell of the egg—is cold and hard. It is made from solid rock. Wherever you are on Earth, even if you are on a ship in the middle of the sea, there is rock beneath you. You are on solid ground.

Just a minute. The school field isn't rock, nor is the park or the garden. That's because the rock is covered with a layer of earth or soil. If you dig down through this soil, you will find rock under it. Everywhere.

Plate Tectonics

About 200 million years ago, the landmasses of Earth were together as one supercontinent. This single landmass was called Pangea. We also know that the hot, molten magma under the surface of the crust pushed the lands apart. And this motion continues today!

The mid-ocean ridge is a huge underwater mountain range. It has a large crack running down its center. That crack is in Earth's crust. It allows molten magma to seep up. When magma reaches the surface, it is called lava. The lava cools and forms new rock on the ocean floor.

Molten magma rises to the surface through cracks in Earth's crust. This makes new crust. Does that mean there is more crust on the surface of Earth now than in the past? No. Geologists had a theory. If Earth oozed molten magma in one place, then it must reabsorb crust somewhere else.

Sure enough, studies began to show that the Atlantic Ocean floor is expanding. But the Pacific Ocean floor is shrinking. It was found that the Pacific Ocean floor dives down into deep trenches under continents. These trenches are called subduction zones. The expanding and shrinking ocean floors are an example of how Earth is really a recycler. Rocks are created and later recycled.

There are two basic types of plates on earth. Oceanic plates are under the ocean water. Continental plates make up

How Does Erosion Work?

Name ________________________________

What You Need:

- newspaper
- two trays
- plastic jug with spout
- water
- block
- three different soil samples

What To Do:

1. Cover your table with newspaper.
2. Put soil 4 cm (2 in.) deep in one tray. Pat the soil down firmly so that it is level.
3. Put one side of the soil tray on a block so that it is on a slope. Put the empty tray under the end of the soil tray. This tray will catch the water.
4. Carefully pour a small stream of water into the top of the soil tray. The water should run down the soil.
5. When water reaches the bottom of the tray, stop pouring and check if the soil is moving. Draw and label a diagram in the box below.

How Does Erosion Work? *(cont.)*

What To Do: *(cont.)*

6. Pour more water into the tray until you notice another change. Then stop to draw and label a diagram in the box below.

Next Question

Repeat the activity, but think of a way to change the setup. How would more or less soil, water, or slope change the results?

Notebook Reflection

Describe erosion that you have seen outside the classroom. Where was it? What caused it? Were people trying to stop it? How?

What Is Inside Rocks?

Name ________________________________

What You Need:

- small rock or pebble
- fabric square
- plastic bag
- hammer
- magnifying glass
- coarse sand
- gravel

What To Do:

1. Wrap the pebble in the fabric square. Put the fabric square inside the plastic bag.
2. Put the plastic bag on the concrete outside. Ask an adult to hit it with the hammer.
3. Unwrap the fabric square. Use the magnifying glass to look at the pebble pieces. Draw what you see:

What Is Inside Rocks? *(cont.)*

What To Do: *(cont.)*

4. Compare the pebble pieces to the sand and gravel. Draw and write about what you see:

Next Question

Repeat steps 1–3 with different pebbles. Are they the same inside, or different?

Notebook Reflection

How do you think the different pieces inside the pebbles got there? Draw and write your ideas.