DIGGING INTO ROCKS WITH YOUNG CHILDREN

An investigation uncovers student knowledge of rocks while laying a foundation for scientific understanding.

By Kathy Trundle, Heather Miller, and Lawrence Krissek

If you have ever watched preschoolers playing on a playground, you know how much they love filling their pockets with rocks and selecting the most interesting ones to take home for their collections. These activities allow young children to form ideas about the fascinating natural world around them. We capitalize on young children's natural interests in Earth materials like rocks and soils to lay the foundation for future learning and a scientific understanding of these concepts.

Rocks and other Earth materials are included in national, state, and local standards. For example, *A Framework for K–12 Science Education* (NRC 2012) contains topics related to Earth systems, which include the hydrosphere, atmosphere, biosphere, and geosphere. By second grade, students should be able to describe how most areas where plants and animals live contain rocks, soils, and sand (Dimension 3: Disciplinary Core Ideas-Earth and Space Science ESS 2.B, p.183).

By the time they enter preschool, most children have some preconceptions about the properties and uses of rocks, some of which may be nonscientific. When asked to describe hand samples of rocks (i.e., a rock that can fit into the palm of the hand) our children immediately respond with the properties of size, shape, and weight. While these aspects are observable properties of rocks, they are not helpful to geologists in identifying individual types of rocks. Typically, students also tend to confuse properties of minerals, such as hardness and luster, with properties of rocks.

The following lesson provides an example of how we help uncover what young children already know about rocks, address misconceptions, and help children begin to construct a scientific understanding of properties of rocks. Children also develop their scientific practices by observing, recording, and analyzing data about rocks, while deepening their understanding of Earth materials. Although we use this lesson in our preschool classrooms, we also offer ways to modify the lesson for older children.

Observing Physical Properties of Rocks

We begin our rock investigation by asking students if they have a special rock or a rock collection at home, which many children do. They share descriptions of their special rock and the aspects that make the rock special to them like, "It's heart shaped," "The colors are pretty," and "My Grandpa found it for me."

Next, we provide a variety of rock samples such as pink granite, limestone with fossils, sandstone, conglomerates with pebbles, obsidian, shale with evident layers, and basalt or pumice with air holes. In Ohio, the Department of Natural Resources provides free rock and

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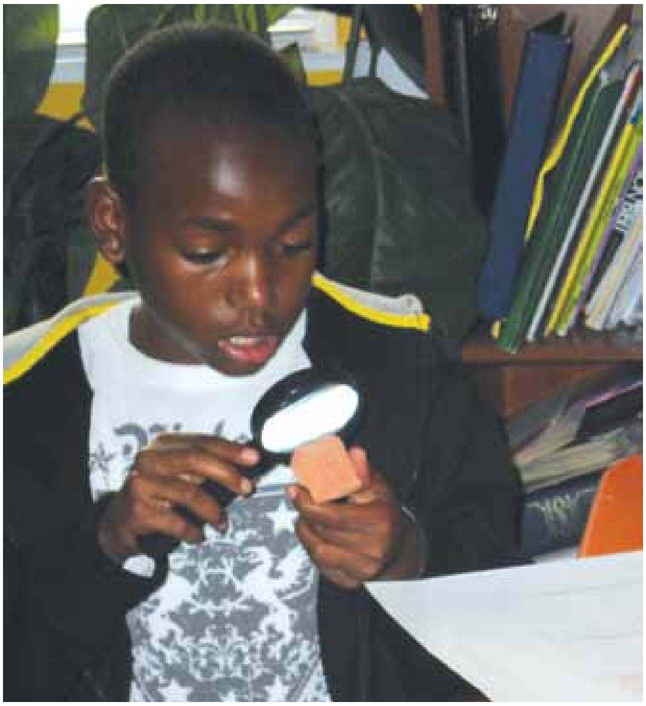


A student examines a rock sample.

mineral sets to resident teachers and organizations. Local college or universities with geology departments may be helpful in identifying local sources, and an internet search also can yield free or low-cost sources.

To uncover preconceptions children have about rocks and to introduce the concept of properties of rocks, we first focus children's observations and ask them to draw a detailed drawing of their hand samples, using colored pencils and white paper. Before distributing rock samples, we discuss safety expectations by reviewing our classroom community rules. Children must keep rocks on the table or securely in their hands, away from their faces and their friends, and they must wash their hands after handling geologic materials.

To complete their drawings, young children usually trace around the outside edges of the specimen and fill in the colors and patterns they see in the rock. Depending on each child's fine motor-skill development, we help some children trace the rock's shape on the paper. To link this part of the investigation to the evidence-based nature of science, we remind children that scientists also use detailed, technical drawings to record observational data in their field notebooks. We emphasize that field geologists record their observations by using drawings and words.

As children are recording their observations, we ask productive questions (i.e., questions that can be answered through children's own observations) to focus their attention on important details they might otherwise overlook:

- What do you notice about your rock?
- What colors do you see?
- How does your rock feel when you touch it?
- Does it have layers like some cakes?
- Does your rock have air holes? If so, what do they look like?
- When you rub your rock, is it crumbly and do pieces flake off or is it not crumbly?
- Does it have fossils? (If our children are not familiar with fossils, we rephrase the question: Does your rock have anything in it that looks like a seashell? Does it have any pieces that look alike?)

This last idea links to pattern recognition, which works across a range of ages and observational abilities. Students are excited about discovering the interesting properties of their rock samples, and comparing it to classmates' samples. Responses we hear include: "Ack! My rock is falling apart!" "My rock is so smooth and shiny black," and "Check out this fossil in my rock! It looks like a seashell!"

Next, the children use hand lenses to look closely at their rocks. We ask, "What can you see with a hand lens that you could not see before?" Students may notice that they can see the smaller bits that make up the rock or additional colors in their rock sample. We ask, "What size are the bits that make up the rock? Big, medium, small, or mixed?" To help children determine the size of the bits, we provide relative sizes for comparisons. Small bits are smaller than sand grains, medium bits are the size of sand grains, and big bits are larger than sand grains. Children record a second drawing of what they see with the hand lens.

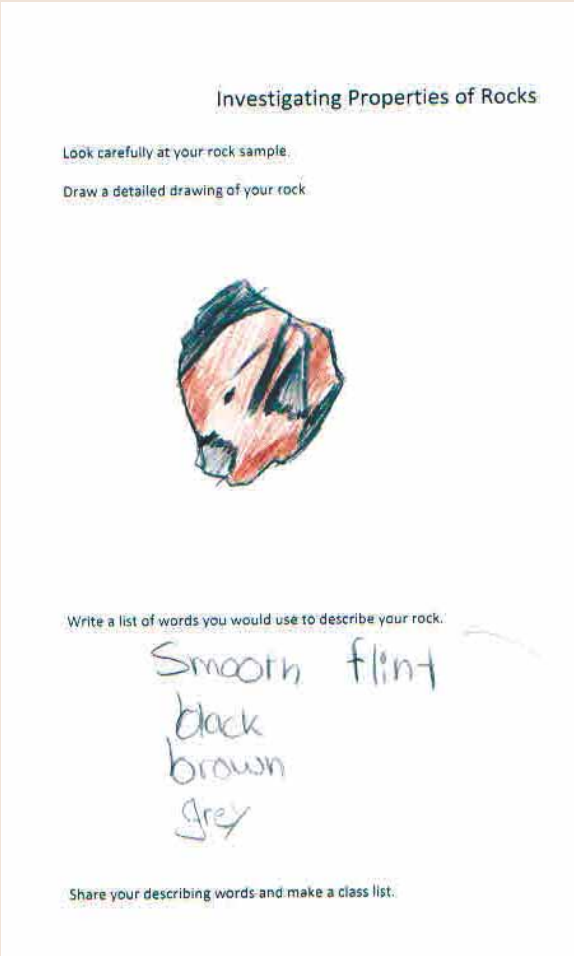
Discussing Findings and Labeling Learning

To summarize the learning, we ask children, "What words can you use to describe the rock?" and we make a class list of descriptive words. Some words our students typically generate for the class list include: *bumpy*, *smooth*, *soft*, *glassy*, *crumbly*, *rough*, *hard*, *pointy*, *layered*, and various color words (e.g., *pink*, *white*, *black*, *gray*). Students add class-generated words to their own rock descriptions if the word also describes their own sample.

Next, we reinforce words that are useful to scientists in their identification of different rocks. We tell students, "Scientists describe rocks by their colors; texture (i.e., the size of the bits that make up the rock); the materials that make it up; whether it contains layers, fossils, or air holes; and how strong it is (i.e., if it crumbles when rubbed)." It is important to note that while the color of a rock is not always diagnostic for scientists, in our experience students almost always identify color as the first property they

Figure 1.

Investigating Properties of Rocks data sheet.


Investigating Properties of Rocks

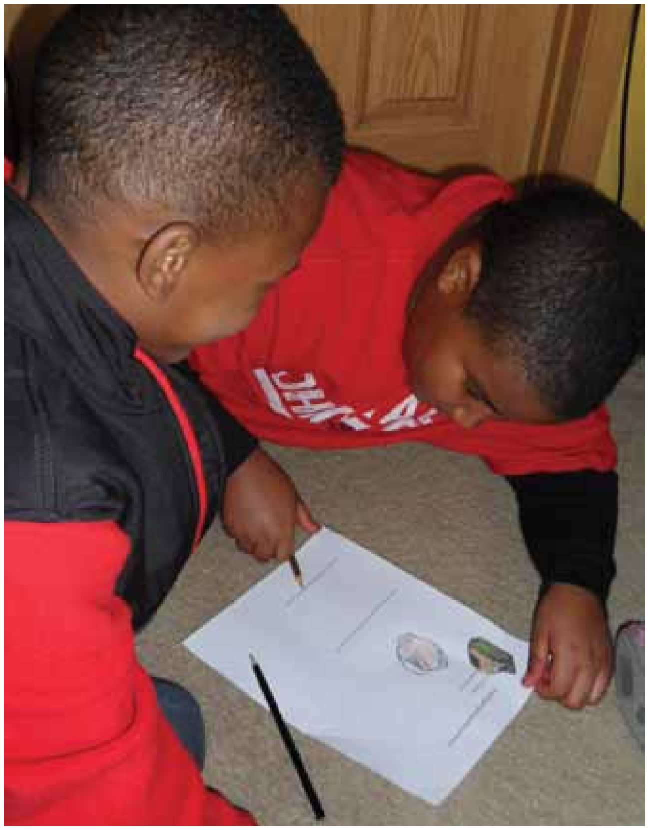
Look carefully at your rock sample.

Draw a detailed drawing of your rock

Write a list of words you would use to describe your rock.

Smooth flint
black
brown
grey

Share your describing words and make a class list.



A student describes his rock on the data sheet.

notice about their rock samples. Geologists use the term *texture* to describe the size of the grains that make up the rock. Texture affects how rough or smooth the inside of a rock feels to the touch. Most hand samples in the kits we use have surfaces where the inside of the rock can be observed in detail. If your samples only have weathered or worn surfaces, you (or students under supervision and wearing goggles) can use a rock hammer to break open the samples, exposing fresh surfaces where children can observe and describe the rocks' textures. Students look at the sizes of the bits or pieces that make up the rocks, and they can use a hand lens to better see and describe the bits.

Another useful property of rocks is strength, or how easily a rock can be broken. Sometimes people confuse hardness as a rock property. However, the Mohs hardness scale describes only minerals—not rocks. The strength of rock samples may be described using adjectives such as "crumbly" or "strong" based on how easily grains or pieces of the rock fall off during handling or by rubbing it gently on a piece of paper. The hardness of a mineral depends solely on the properties of that mineral, whereas the strength or competence of a rock depends on the properties of the minerals in that rock, the strength and amount of the material holding those grains together (e.g., cement for sedimentary rocks; groundmass for igneous and metamorphic rocks), and the effects of any layers of weakness that affect the rock mass overall (e.g., joints, fractures, bedding planes). A helpful analogy could be to think of the hardness of minerals as a property of a building's materials (e.g., properties of bricks) and rock strength as a property of a building made of that building material (e.g., bricks joined with mortar or bricks that are simply stacked).

We emphasize that some of our observable properties of rocks are not useful in helping scientists determine the type of rock; for example the hand sample's shape and size. We work with children to make certain they include observations that are useful to scientists like those listed above.

We help children begin to understand the scientific meanings of certain words that also have other conventional meanings in our everyday lives. As previously noted, geologists use the word *texture* to describe the size of the bits or small pieces that make up a rock. Children often describe a rock as having a smooth texture when the surface area of the rock is weathered. The weathered surface might feel smooth to the touch. However, the texture of the rock involves the pieces or bits that make up the inside of the rock. Another example is the term *hardness*, which scientists use to describe the relative resistance of a mineral to scratching. Children typically use "hardness" to mean how rigid an object is or how resistant it is to bending or breaking.

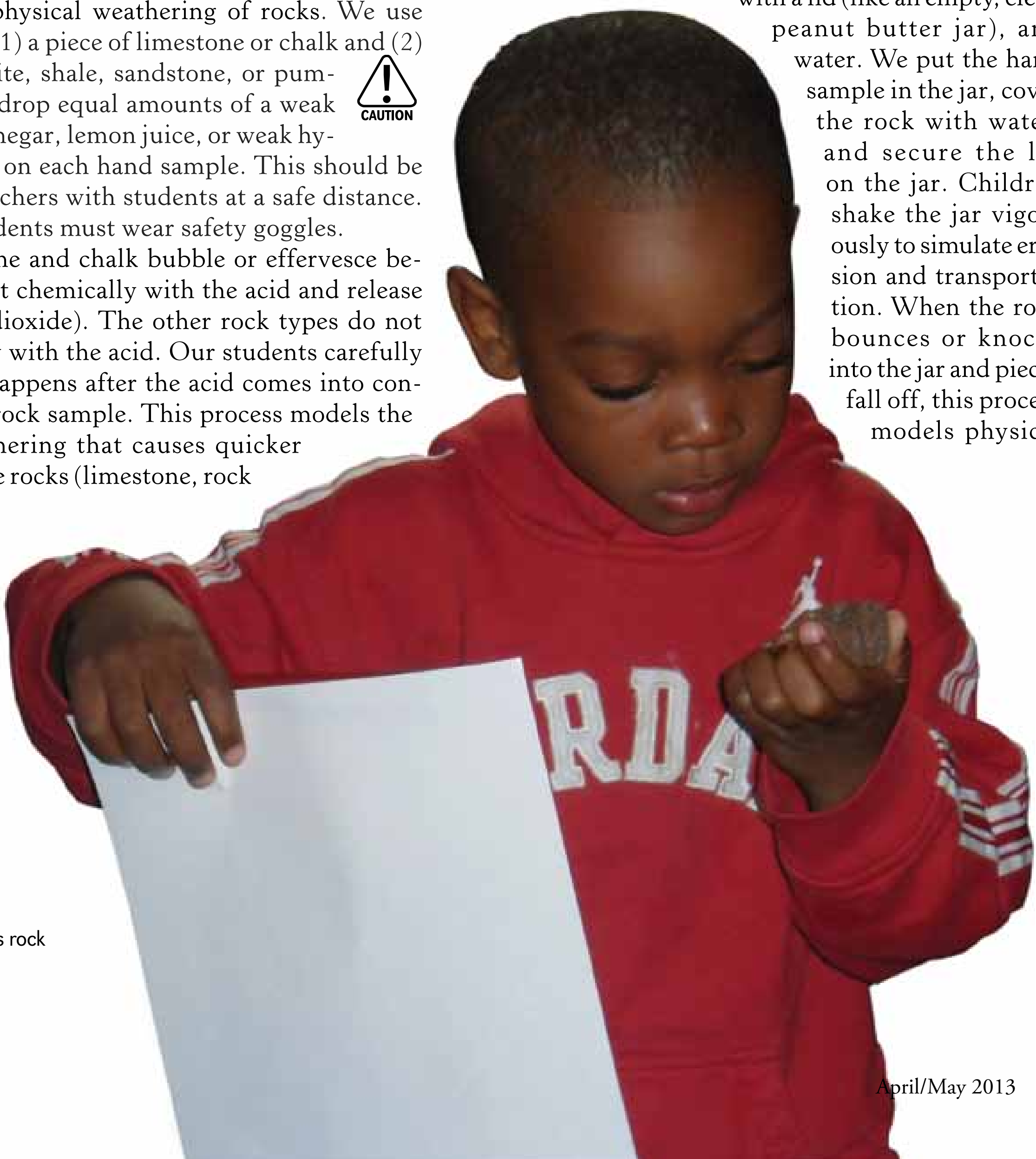
Modeling Processes of Change

Older children (second or third grade) use the Investigating Properties of Rocks data sheet (see Figure 1 and NSTA Connection) to record their observations of properties of rocks. We follow the observable properties lesson with lessons that help older children begin to understand processes that change Earth materials such as weathering and erosion. We use the following investigations with our students to simulate chemical and physical weathering of rocks. We use two materials: (1) a piece of limestone or chalk and (2) a piece of granite, shale, sandstone, or pumice. We slowly drop equal amounts of a weak acid, such as vinegar, lemon juice, or weak hydrochloric acid on each hand sample. This should be done by the teachers with students at a safe distance. Otherwise, students must wear safety goggles.

CAUTION

The limestone and chalk bubble or effervesce because they react chemically with the acid and release a gas (carbon dioxide). The other rock types do not react as quickly with the acid. Our students carefully observe what happens after the acid comes into contact with each rock sample. This process models the chemical weathering that causes quicker changes in some rocks (limestone, rock salt). Limestone, which is a broad category of common sedimentary rocks that includes chalk, fossiliferous limestone, travertine, coquina, and so on, is widely used as the example of a rock type that undergoes rapid chemical weathering. Some other rock types, such as rock salt (halite), also undergo rapid chemical weathering but are less common than limestones. Yet other types of rocks are less susceptible to chemical weathering but range from moderately fast-weathering to relatively slow-weathering. For example, in warm humid climates basalts weather relatively quickly (but not as fast as limestones), whereas granites weather relatively slowly. During chemical weathering, the components of rocks interact with water or air, which changes the composition of the rocks. Some organisms, such as lichens (i.e., a fungus and a photosynthetic partner [alga or cyanobacterium] in a symbiotic relationship), give off weak acids, which also can cause rocks to weather.

For a second investigation about changes in Earth materials, we use a piece of sandstone, a clear plastic jar with a lid (like an empty, clean peanut butter jar), and water. We put the hand sample in the jar, cover the rock with water, and secure the lid on the jar. Children shake the jar vigorously to simulate erosion and transportation. When the rock bounces or knocks into the jar and pieces fall off, this process models physical



A student studies his rock closely.

weathering. Physical weathering makes rocks smaller through applied forces, such as collisions with other rocks and materials while being carried in a stream, when a tree root grows into a crack in a rock and splits it apart, or when the heating and cooling of rocks due to climatic conditions causes them to crack.

Weathered rocks, or sediment, can be moved by the wind or water and deposited in another place. Students can look at pictures of places where erosion has changed the landscape, such as the Grand Canyon, or the glacial grooves on Kelley's Island in Lake Erie. If your school is located near a coastline, erosion due to wave action can be a local issue of concern. Inland areas may have examples of wind, gravity-driven (e.g., slumps or landslides), or glacial erosion in the region where students can make a connection with how the geologic cycle has affected their community.

Connecting Earth Concepts to Children's Literature

With older students, we also read several books about rocks and rock collecting. *Everybody Needs a Rock* by Byrd Baylor (1985) entertainingly describes the "rules" for finding your perfect rock. *Rocks in His Head* by Carol Otis Hurst (2001) tells the story of a man who was fascinated with rocks, collected and studied them all of his life, and eventually became a curator at a rock museum. The book *If You Find a Rock* by Peggy Christian (2008) poetically describes the many types of rocks that children may encounter in their daily lives, such as skipping rocks, chalk rocks, resting rocks, or worry rocks. All of these books are useful for reinforcing ways that we use rocks in daily life and are interesting to read. However, these books do not include scientific concepts. *Rocks and Soil* published by National Geographic (Kay 2011) includes spectacular photographs and is an excellent resource for scientifically accurate information about properties of rocks. Although this book is geared for children in first grade and above, the photographs are useful with younger children and as a classroom reference book. Other reference books in our classrooms include *Rocks and Minerals* (2002) and *Fossils* (2002), both by Ann O. Squire. We introduce these books after the rock investigations described above. For example, the National Geographic book can be used as an extension to allow children to compare their rock hand sample back to the images of the rocks in the book, "How is your rock alike and different from the rocks in the book?"

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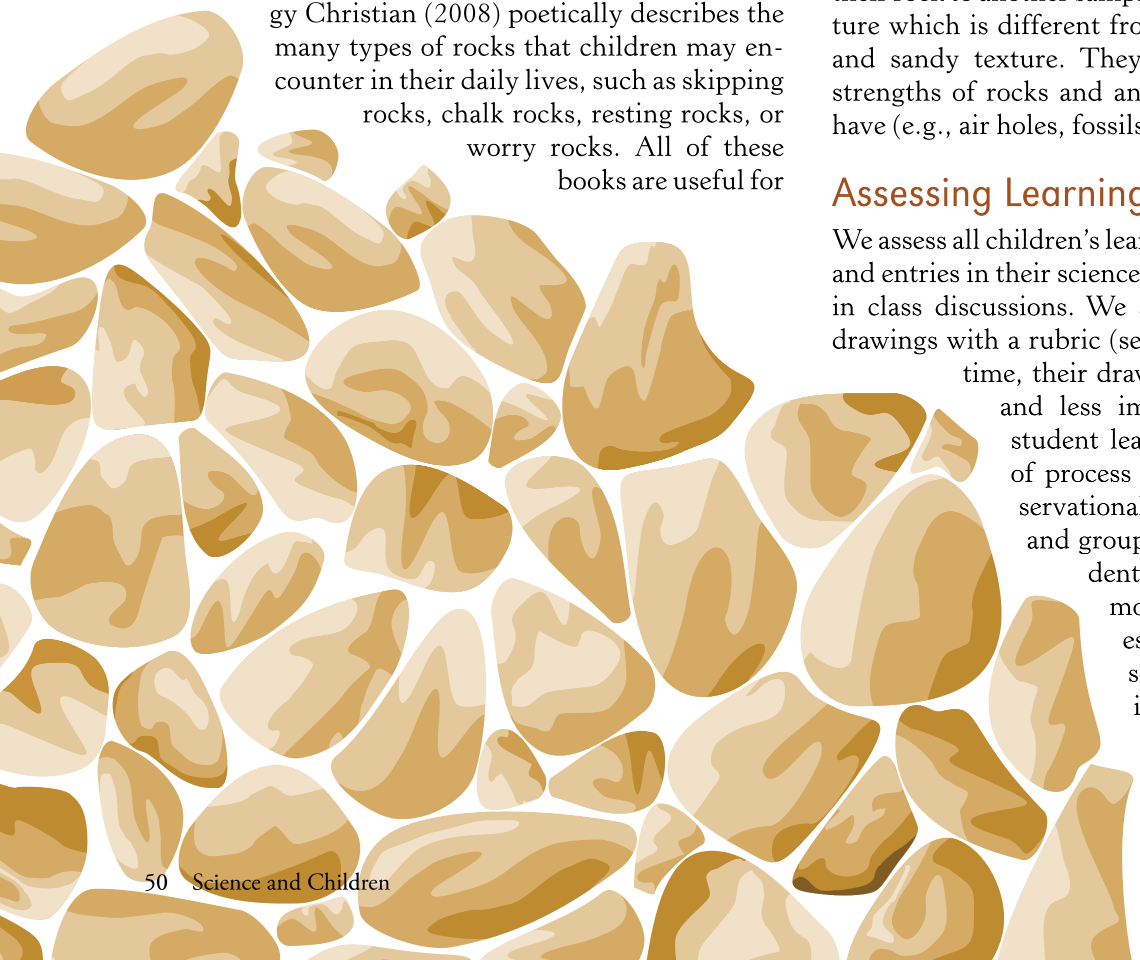
Applying Learning

To apply the learning, our older and younger children go on rock scavenger hunts and identify the different ways people use rocks (e.g., building materials, decorations, and jewelry). Students also compare their rock samples to other children's rock samples in a variety of ways. For example, they can compare the texture of their rock to another sample. Obsidian has a glassy texture which is different from sandstone with its rough and sandy texture. They also compare the relative strengths of rocks and any special features the rocks have (e.g., air holes, fossils, layers).

Assessing Learning

We assess all children's learning through their drawings and entries in their science notebooks and participation in class discussions. We assess our young children's drawings with a rubric (see NSTA Connection). Over time, their drawings become more detailed and less imaginative—an indicator of student learning and the development of process skills. We use our own observational data of class discussions and group work to determine the student's strengths and areas where more experience may be necessary. By the end of the lesson, they should be able to identify at least three properties that scientists use to describe rocks and at least one way that rocks change



Students use a magnifying glass to observe a rock.

over time. In addition, we consider to what extent students participate in class discussions and use evidence to guide their questions and support their ideas. Evidence can be presented in writing, pictures, data tables, or by verbal explanations with a scribe or recording device. To simplify the assessment of skill improvement, at times we use a checklist for the areas of proficiency being targeted in the unit. Older students can summarize their learning and practice their writing and argumentation skills by writing a summary report, which contains statements based on their observations (e.g., "I collected…" "I saw…" "My data showed…" and so on). Using indicators of each individual student's skill level before the introduction of the topic allows us to more accurately assess a child's development of competence in the targeted areas.

Conclusion

Providing opportunities for children to make observations about rocks and practice their science process skills will guide them to further think like scientists as they explore the natural world to satisfy their innate curiosities. ■

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Connecting to the Standards

This article relates to the following National Science Education Standards (NRC 1996):

Content Standards

Grades K–4

Standard D: Earth and Space Science

- Properties of Earth materials

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NSTA Connection

For the Investigating Properties of Rocks data sheet and the rubric for rock drawings, visit *www.nsta.org/SC1304*.