Is It a Rock? Continuous Formative Assessment

By Page Keeley

When elementary teachers ask, "When and how often should I use formative assessment?" my answer is "continuously, throughout instruction." Formative assessment can be used prior to a lesson for the purpose of eliciting students' preconceptions. It can also be used throughout the instructional cycle as students explore their ideas and develop and refine new conceptual understandings. Formative assessment is also used at the end of a sequence of instruction to provide an opportunity for students to refine their thinking and reflect back on how their ideas have changed. This month's column will show how the formative assessment probe "Is It a Rock?" (Keeley et al. 2007; Figure 1) can be combined with a formative assessment classroom technique (FACT), the group Frayer Model (Keeley 2008), to continuously inform teachers of their students' progress toward meeting the intended learning goals and engage students in rethinking their ideas as new information is assimilated.

Children are continually developing ideas and explanations about their natural world. Many of these ideas come from their daily interactions with natural phenomena. Others come from ideas they pick up through the media, other students, and adults. Some of these ideas are consistent with the science children are taught; others differ significantly from scientific explanations. Many of these ideas will follow students into adulthood if they remain hidden from the teacher and unresolved. The challenge for teachers is to find ways to elicit these ideas and then use appropriate strategies to move students' learning forward. The *Uncovering Student Ideas in Science* series, published by NSTA, provides K–12 teachers with a source of highly engaging science questions that link instruction and assessment and target key ideas in the standards. These questions, called formative assessment probes, are used to expose students' preconceptions; encourage evidence-based explanations, talk, and argument; and monitor students' progress in achieving conceptual understanding. Combined with various formative assessment classroom techniques (FACTs), probes not only assess where students are conceptually, they also promote learning and inform effective teaching. This is the essence of formative assessment. Each month, this column features a probe and describes how elementary science teachers can use it with effective strategies to build their formative assessment repertoire and improve teaching and learning in the elementary science classroom. See NSTA Connection for more background on using formative assessment probes.

The following describes how the probe and this FACT can be used together throughout a learning cycle of continuous assessment and instruction to both promote learning and inform instruction.

The formative assessment probe, "Is It a Rock? (Version 2)" connects two related elementary core ideas from *A Framework for K–12 Science Education* (NRC 2012). In Physical Science Core Idea PS1, elementary students develop the idea that matter can be described and classified by its observable properties, by its uses, and by whether it occurs naturally or is manufactured. In Earth Science core idea ESS2, students develop the idea that the geosphere, one part of the Earth system, is made up of rock, soil, and sediments. The probe combines these two ideas to help teachers examine how their students use the concepts of properties of matter, natural versus human-made materials, and the geologic origin of a material to distinguish between rocks and materials that are "rocklike."

The Frayer Model, developed by Dorothy Frayer and her colleagues at the University of Wisconsin, was originally designed as a strategy to support concept mastery (Frayer et al. 1969). The strategy is frequently used in literacy to support vocabulary development in the content areas. As a formative assessment classroom technique (FACT), it activates students' thinking about a concept and can be used to assess conceptual understanding.

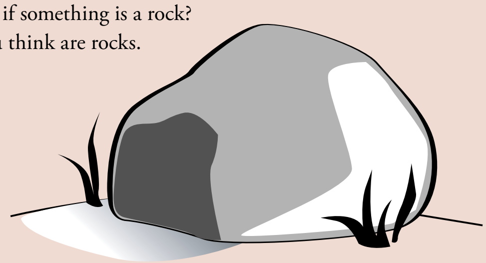
Typically, students individually complete a Frayer Model worksheet by filling in the definition of a targeted concept (in their own words), characteristics of the concept, and examples and non-examples of the concept. However, the Frayer Model can also be used as an interactive strategy where students work collaboratively in small groups of three or four to come up with a collective answer to each of the sections of the Frayer Model. Instead of individual worksheets, prepare a classroom chart of the Frayer Model and give each group four different-color sticky notes, color-coded for each section of the chart. Each group discusses their ideas and comes up with a collective response for each section. Each group's responses are recorded on the notes and placed on the chart to share with the class (Figure 2, p. 36).

Figure 1.

"Is It a Rock?" formative assessment probe.

Is It a Rock? (Version 2)

What is a rock? How do you decide if something is a rock?
Put an X next to the things that you think are rocks.



___ cement block	___ piece of clay pot	___ coal
___ dried mud	___ coral	___ brick
___ hardened lava	___ limestone	___ a gravestone
___ asphalt (road tar)	___ iron ore	___ marble statue
___ glass	___ concrete	___ granite

Explain your thinking. What "rule" or reasoning did you use to decide if something is a rock?

Elicitation

In this phase of a learning cycle, the "Is It a Rock?" probe is used to activate students' thinking and draw out prior knowledge of rocks students bring to their learning. Introduce the probe and go over each item on the list, making sure students are familiar with each object. You may show an actual object from the list, such as a piece of granite, or pictures of the objects on the list, such as a marble statue, to make sure students have some familiarity with each object before responding to the probe. Students then answer the probe individually in writing.

Exploration and Discovery

In this phase, students form small groups to share their individual ideas with their peers and seek to discover new knowledge through the small group discussion (science talk). Each student in the group explains his or her response to the probe, seeking feedback from the group, and evaluates the ideas of others in the group as they share their ideas. Then, introduce the group Frayer Model FACT, explaining how each group is to come up with a consensus response for the targeted concept of "rock" for each section of the chart. For the Examples and Non-Examples section, instruct the students to use the objects listed on the "Is It a Rock?" probe.

After each group posts their responses on the chart and examines the sticky notes from other groups, summarize the chart for the class and point out similarities and differences in their ideas, taking care at this point not to pass judgment on whether students'

Figure 2.

Frayer Model class chart.

ideas are right or wrong. Explain how the class will explore these ideas further and revisit the same probe again after students gather more information. Then, use the data from the group Frayer Model to formatively design a lesson or set of lessons that will move the class toward a scientific understanding of a rock as a natural material formed in the Earth through geologic processes. By examining the groups' responses, you may identify commonly held difficulties in distinguishing between things that are hard or made by humans out of earth materials and actual rocks made through geologic processes. Other difficulties, such as whether a hard, naturally formed material like coral is considered a rock, might also surface. All of these initial ideas are taken into account as you design lessons that will help the class construct new knowledge and understanding about what materials or objects are considered to be rocks.

Concept Development and Transfer

After students have had an opportunity to further explore their ideas, be confronted with new scientific information that challenges their initial ideas, and revise their thinking, have the students respond again to the "Is It a Rock?" probe. Give each student an opportunity to revise their original answers based on what they now know. Have students share their new thinking in their small groups and complete a new sticky note, which is placed over their first note to show how each group's ideas have changed (or in some cases, stayed the same). Facilitate a discussion with the whole class, giving each small group an opportunity to share and defend their ideas. At this point, address any difficulties or misunderstandings the students may still have. Now you are ready to guide the whole class in creating a class Frayer Model. Remove the sticky notes and, together with the class, fill in the Frayer Model to represent the class's scientific understanding of the concept of a rock.

Now that the students have developed a formal scientific understanding of what a rock is and how it differs from "rocklike" materials, add another assessment opportunity to see if students can transfer what they learned to new examples. List five new objects: block of ice, shell fossil, floor tile, quartz, and piece of pottery, and pass a sample of each around for the students to examine. Ask them to meet in their small groups and decide which ones are examples of rocks and which are non-examples, using the definition and characteristics on the whole-class Frayer Model chart. As each group shares their thinking, assess how well the class is able to transfer their new knowledge to categorizing new objects.

Reflection

Reflection provides a metacognitive opportunity for students to recognize how their thinking has changed as a result of their instructional experiences. Once again, ask students to examine their initial response to the probe and the class chart and think about how their ideas have changed up to this point. Each student then completes a reflection exit ticket by filling in the blanks: I used to think ______, but now I know ______. I know this because ___________. Collect the reflections and examine them for evidence of conceptual change and indicators of the lessons' effectiveness.

This is just one example of the continuous use of the same formative assessment probe combined with a FACT to encourage group discussion, sharing, evaluation of ideas during different phases of instruction and learning, and reflection. The next time you select a probe and a FACT to use with that probe, consider how you can optimize their use throughout your sequence of instruction. ■

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References

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NSTA Connection

Download the "Is It a Rock?" probe at *www.nsta.org/SC1304*. Read selections from the entire introduction to *Uncovering Student Ideas in Science* series at *www.nsta.org/publications/press/uncovering.aspx.*

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