Assessment serves many purposes in the elementary classroom. Formative assessment, often called assessment for learning, is characterized by its primary purpose—promoting learning. It takes place both formally and informally, is embedded in various stages of an instructional cycle, informs the teacher about appropriate next steps for instruction, and engages students in thinking about their own ideas. Formative assessment can take many forms. One form that has been used successfully in science education is the formative assessment probe. The *Uncovering Student Ideas in Science* series published by NSTA provides science educators with an extensive bank of formative assessment probes (see Internet Resource for information on the series). These probes are used to reveal the ideas students bring to their learning before instruction (preconceptions) as well as the conceptions formed throughout the instructional cycle. Merely gathering this information does not make a probe formative. It is only formative when the information is used to improve teaching and learning. Each month, this column features a probe and describes how elementary science teachers can use it 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.
Formative assessment is used to gather information about students’ thinking related to core ideas as well as their ability to engage in scientific practices such as evidence-based argumentation. Let’s examine how a teacher can use a formative assessment probe and formative assessment classroom techniques (FACTs) to uncover students’ ideas, make instructional decisions, and foster conceptual learning. The assessment probe “Where Did the Water Come From?” elicits students’ preconceptions about condensation phenomena (Keeley, Eberle, and Dorsey 2008). The probe can be used with FACT claim cards to engage students in the scientific practice of engaging in argument from evidence. Claim cards are just that, cards on which students write a claim, in this case their probe answer. These assessment tools and techniques target the initial idea that water can be in the air around us in a form we cannot see called water vapor. The teacher can then use evidence of the students’ understanding of this fundamental idea to further develop the crosscutting concept of the cycling of matter in the context of the water cycle.

Prior to teaching a sequence of lessons to help students develop a conceptual understanding of the processes of evaporation and condensation, the teacher gave students the probe and asked them to complete it individually. As she taught fifth-grade students, she did not expect them to use ideas about energy or the motion of molecules in their explanation. She was interested in how they explained the phenomenon macroscopically using their operational understanding of condensation. As she reviewed their answer choices and explanations, she noted that almost two thirds of the class attributed the puddle to water from the inside of the container (choices B, D, and E). Some students attributed the phenomenon to coldness being changed into water which was consistent with the research conducted by Bar and Travis (1991) described in the teacher notes for the probe. Some students correctly chose A and explained that evaporated water in the air touched the cold container and turned to a liquid. She took note of these students for the next day’s activity.
The next day she had her students form small groups of six, making sure there was at least one student in each group who chose response A. She gave each group a set of six FACT claim cards (Keeley, forthcoming). Students recorded their answer choices to the probe in claim format using a complete sentence (as instructed to do when they previously learned how to state a claim). For example, the card for response A stated: The puddle of water came from a gas in the air; the card for response B stated: The puddle of water came from melted ice inside the container, and so forth.

Each student then took turns reading the claim on their card to their group, and together the group decided whether they agreed or disagreed with each claim, supporting or refuting the claim with evidence. Some students pointed out why the evidence for some of the claims accepted by other members of the group was faulty, using reasoning from their everyday experiences and understanding of science concepts. After the small group discussion, each group was instructed to select the claim they could all agree on and construct an argument to present to the class as to why they thought it was the best claim. As the groups presented their claims and evidence to the whole class and engaged in argumentation with their peers, some students’ ideas began to change or deepen. Eventually the whole class settled on the claim that the water came from a gas in the air and could explain the evidence that supported the claim. In essence, these students were engaging in the scientific practice of argumentation using claims and evidence (Dimension 1). At the same time they were socially constructing a core idea that would help them make sense of the phenomenon of water appearing on the outside of a cold object (Dimension 3).

This opportunity to develop conceptual understanding of a core idea through claims and evidence-based argumentation preceded the teacher’s formal introduction of the terminology and processes of evaporation and condensation. She then used an additional probe, Wet Jeans (Keeley, Eberle, and Farrin 2005), and other FACTs to elicit further evidence of their conceptual understanding of evaporation and condensation.

The Framework notes that “students’ understanding of crosscutting concepts should be reinforced by repeated use of them in the context of instruction in the disciplinary core ideas” (NRC 2011, p. 101). In turn, the crosscutting concepts (Dimension 2) can provide a connective structure to support students’ understanding of disciplinary content (Dimension 3). Energy and matter: Flows, cycles, and conservation is one of the crosscutting concepts. This crosscutting concept is described as “tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems’ possibilities and limitations” (NRC 2011, p. 84). As the teacher listened carefully to the students identify and explain the puddle and other phenomena, such as why wet dew forms on the grass in the morning, she then began to think about experiences that would help them use the crosscutting concept of matter cycles. She used information about her students’ present understanding of evaporation and condensation to plan instruction that would help them understand the bigger idea about how water cycles between the atmosphere and the surface of the Earth.

Integrating across the three dimensions in the Framework—scientific practices, crosscutting concepts, and disciplinary core ideas—will present a new challenge to science teachers as they plan for curriculum, instruction, and assessment. As this example illustrates, the assessment probes in the Uncovering Student Ideas series, used with formative assessment classroom techniques (FACTs), provide interesting and engaging contexts and strategies for linking these three dimensions while assessing and promoting deeper conceptual learning.

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Internet Resources
Uncovering Student Ideas
www.uncoveringstudentideas.org

References
NSTA Connection

Download the “Where Did the Water Come From?” probe at www.nsta.org/SC1207.


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