

Using Formative Assessment Probes to Develop Elementary Learning Stations

By Page Keeley

Many elementary teachers use exploratory learning stations to help students learn about a science topic in myriad ways and use different skills and practices to develop scientific concepts and ideas. All stations typically involve activities where students can independently observe, test their ideas, develop models, collect and analyze data, make drawings, and obtain information from text or multimedia to explain phenomena and begin to construct ideas that will be further developed during the instructional cycle. Students rotate through the stations usually with a partner or small group, in sequence or in random order, recording their station work in science notebooks or journals. After completing the stations, students assemble for a student scientist meeting facilitated by the teacher to discuss their findings and begin development of formal conceptual understanding that can be applied to a new situation or context. For more information about developing, setting up, and managing learning stations, read the Jarrett (2010) *Science and Children* article.

Formative assessment probes provide an opportunity to elicit students' thinking before and after they engage in the exploratory phase of learning. Formative assessment is often referred to as assessment *for* learning, rather than assessment

of learning, as it happens during the learning process (Keeley 2015). The preposition makes a difference! When formative assessment probes are used to develop learning stations, the stations become assessment *as* learning because the formative assessment probes also serve as the learning station activity.

Take the topic of magnetism, a common curricular topic in the elementary grades. In the *Next Generation Science Standards*, third graders learn about magnetic interactions and are expected to apply scientific ideas about magnets to a design problem. Table 1 shows the probes selected to develop learning stations about magnets and magnetic interactions, the ideas elicited by the probe, and the station activity used with the probe. Several of the probes, known as P-E-O probes, work very well in exploratory learning stations. P-E-O probes ask students to make a prediction (P), explain the reasoning that supports their prediction (E), and test their prediction by making actual observations (O). When their observations do not support their prediction, students need to reconsider their initial explanation. During the sense-making discussions that follow the completion of the learning stations, students revisit the probe to construct a scientific explanation, based on evidence from their obser-

vations and the scientific discussion held during the student scientist meeting.

There are eight learning stations for the topic of magnets and magnetic interactions. Each probe is displayed at a station. Students go through the stations in two rounds. In the first round, with a partner or in a small group, students discuss the probe, what they think is the best answer choice, and construct an initial explanation for their answer choice. They record this information in their science notebooks for each probe station. Station 4 "Can You Pick It Up With a Magnet?" (Figure 1, p. 30) features a set of cards displaying each object (Keeley and Harrington 2014). Students sort the cards into three columns: things they think a magnet can pick up, things they think a magnet will not pick up, and things they are unsure about or do not all agree on. They then record the results of Station 4 in their science notebooks as well as the rule or reasoning they used to decide if there is a magnetic interaction. It is best to use a card-sort for this type of probe because you have the option to select only the materials that are available for you. The card-sort strategy also promotes discussion and argument.

After students complete the elicitation round, hold a class discussion to provide an opportunity for stu-

dents to share their initial ideas, but do not correct misconceptions. It is important to honor students' contributions and make a list of class ideas to revisit after the second round of stations, where students will gather evidence to answer the question posed by the probe. Listen carefully as students share their thinking to gain insight into ideas that may develop over time and to know what

to look and listen for as students interact with the materials at each station in the next round. Instead of a discussion, the teacher may decide to collect students' notebooks and read through their entries before the next day of station exploration. If you choose to do this, summarize for students what you learned about their thinking and make a list of initial class ideas before starting the ex-

ploratory round.

In the exploratory round, materials are set out for each station (except for Station 8, which asks students to draw a conceptual model). For example, in Station 4, students use a magnet to test the objects listed on each card. Additional prompts can be added to the stations. For example, Station 2 could include a book providing

TABLE 1.

Learning station probes for magnets and magnetic interactions.

Probe	Purpose of the probe	Learning station activity
Station 1: Can Magnets Push or Pull Without Touching? (Keeley and Harrington 2014)	Do students recognize that magnetism is an action-at-a-distance force?	Predict-explain-observe
Station 2: What Happens if You Use the Other End of the Magnet? (Keeley and Harrington 2014)	Do students recognize that magnets have two poles and that both ends interact with a steel paper clip in the same way?	- Predict-explain-observe - Draw and label ends of a magnet - Obtain information
Station 3: Big and Small Magnets (Keeley 2013)	Do students think the size of a magnet affects the strength of the magnetic interaction?	- Design an experiment - Analyze and display data
Station 4: Can You Pick It Up With a Magnet? (Keeley and Harrington 2014)	What kinds of materials do students think interact with a magnet?	Card-sort followed by observations
Station 5: Does a Magnet Pick Up any Kind of Metal? (Keeley and Harrington 2014)	Do students overgeneralize and think magnets interact with all metals?	- Predict-explain-observe - Construct an argument
Station 6: Magnets in Water (Keeley and Tugel 2009)	Do students think magnets work when covered in water?	- Predict-explain-observe - Brainstorm applications
Station 7: What Happens When You Wrap a Magnet With Aluminum Foil? (Keeley and Harrington 2014)	Do students think a magnet will interact with a paper clip if it is completely covered with aluminum foil?	- Predict-explain-observe - Develop new questions
Station 8: What Happens When You Hold a Magnet Near a Refrigerator? (Keeley and Harrington 2014)	How do students represent a magnetic interaction? What symbols do they use?	Draw a symbolic representation

information about magnetic poles to help students draw and label the ends of a magnet. Station 4 may ask students to plan, describe, and carry out an investigation and make a display of their data. In Station 5 students may be asked to construct an argument that supports their claim. After testing their prediction in Station 6, students could brainstorm a list of ways an engineer might use his or her findings to solve an underwater problem. Station 7 could ask students to generate new questions they have about this phenomenon.

In Station 8, students could be asked to evaluate the different symbolic representations shared by the class and choose the one they think is the best way to represent a magnetic interaction. In considering extensions to the probe for each station, draw upon scientific practices that support the learning at each station.

During the exploratory round, the teacher observes students interacting with the materials, while discussing and revising their initial ideas. He or she makes note of students' misunderstandings that will

need to be addressed during the whole-class discussion. The teacher also notes particular students who can support the development of scientific thinking by sharing their ideas during the student scientist meeting.

As in the first round, students record the results of each probe activity in their science notebooks. They may revise their initial response to the probe and construct a new explanation, based on the evidence and information obtained at the station. Students then use their notebooks for the sense-making round as the teacher facilitates a student scientist meeting.

During the whole-class discussion, students decide which ideas on their initial list of class ideas should be discarded and which ones should be kept, providing evidence to support their decision. Each station is discussed, concepts are formalized, terminology is introduced, and the class works together to construct a consensus for a scientific explanation for each probe. For Station 8, students decide and explain their reasoning for the best representation for magnetic interaction. Students are also given the opportunity to reflect back on their initial station notebook entries, share how their thinking has changed, and raise any new questions. During the discussion, the teacher makes note of any additional opportunities students may need to solidify their thinking.

You may be wondering how to assemble a collection of related probes for the stations' learning goals. You can search across the collection of 311 *Uncovering Student Ideas in Science* formative assessment probes. Each book includes a concept matrix that

FIGURE 1.

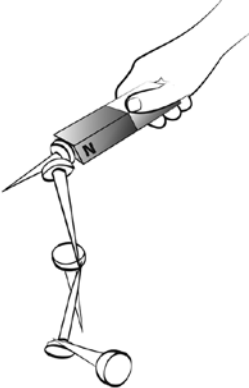
"Can You Pick It up With a Magnet?" probe—Station 4.

Can You Pick It up With a Magnet?

Some things can be picked up by magnets. Some things cannot. Put an X next to the things on the list you think can be picked up by a magnet.

☐ cloth	☐ silver (metal)	☐ wood
☐ steel (metal)	☐ aluminum (metal)	☐ leather
☐ copper (metal)	☐ other magnets	☐ plastic
☐ iron (metal)	☐ glass	☐ tin (metal)
☐ pencil lead (graphite)	☐ paper	☐ mirror

Explain your thinking. What rule or reasoning did you use to decide if something can be picked up by a magnet?



lists the major concepts addressed by each probe. The newer editions also include the related NGSS disciplinary core ideas. Probes covered in the *Uncovering Student Ideas in Science* series that could be used to develop learning stations include: light; conservation of matter; floating and sinking; Earth, Moon, and Sun; Earth, Sun, and shadows; the night sky; solids and liquids; magnetism; electric circuits; electric charge; position and motion; weathering, erosion, and deposition; water cycle; weather and climate; needs and processes of living things; and flow of matter through ecosystems. ■

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