Where Are the Stars?

By Page Keeley

Gazing at the night sky is a familiar experience for many elementary students. Depending on where children live, they can often look out a window and see the Moon and stars (though in urban areas some children may not be able to observe stars in their immediate environment). Some students can even distinguish between “very bright stars” and planets. Children have “seen” the night sky in other ways as well. They may have seen the Moon and stars in television shows, movies, posters, or children’s picture books. Regardless of whether they see the Moon and stars firsthand or vicariously, the Moon and the stars in the night sky are a familiar sight.

“Emmy’s Moon and Stars” (Figure 1) is a formative assessment probe designed to find out whether students recognize where the stars are in relation to the Earth and the Moon (Keeley et al. 2007). The Earth and the Moon are both part of our solar system. What about stars?

Where do students think the stars are in relation to other bodies in our solar system? How far away do they think they are?

Sixty-four fifth graders field-tested this probe. Prior to fifth grade, the students in the field test learned about the solar system. Some students studied the solar system in third grade; others in fourth grade. From the sample of students who answered this probe after learning about the solar system, the results were surprising. When asked to describe where the Moon and the stars were that Emmy could see through her window, this is what they thought:

- 19% chose the best answer—A. There are no stars between the Earth and the Moon.
- 15% chose answer B. One star is between the Earth and the Moon.
- 41% chose answer C. A few stars are between the Earth and the Moon.

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.
• 10% chose answer D. There are many stars between the Earth and the Moon.
• 15% chose answer E. There are several stars between the Moon and the edge of our solar system.

In all, 19% of the students chose the correct response, whereas 81% of the students chose an incorrect response. What does this tell us about students’ ideas and how we can use this data to inform instruction (which is the purpose of formative assessment)? To answer that question we need to examine the students’ thinking about the Earth, Moon, stars, and their position in the solar system and beyond. The selected responses alone do not provide much information about what each student is thinking.

For this reason, every assessment probe in the Uncovering Student Ideas series is two-tiered. It begins with a selected response section in which students are given answer choices to pick from that best match their thinking. The second part of the probe is an open-response format in which students are asked to explain their thinking. Although a quick tally of selected answer choices can give the teacher a sense of the extent to which the class understands the concept being addressed, it is the careful examination of students’ thinking in the second part that reveals the various ideas students drew upon to select their answer choice. This information can come from students’ written explanations or from class discussions using a variety of FACTs (formative assessment classroom techniques) that engage students in defending their ideas (Keeley 2008).

**Figure 1.**
**Emmy’s Moon and Stars.**

Emmy looked out her window and saw the Moon and stars. She wondered how far away they were. Circle the answer that best describes where you think the Moon and stars are that Emmy sees.

A. There are no stars between the Earth and the Moon.
B. One star is between the Earth and the Moon.
C. A few stars are between the Earth and the Moon.
D. There are many stars between the Earth and the Moon.
E. Several stars are between the Moon and the edge of our solar system.

Explain your thinking.

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**Guiding Instruction**

Sometimes students’ ideas come from misinterpretations of taught concepts, misrepresentations in books and other media, pieces of scientific ideas that have not yet been strung together in a cohesive and coherent way, intuition, or their own “common sense” way of thinking about phenomena. As far as formative assessment goes, it is this second part of the probe that yields the most useful information about students’ ideas teachers can use to inform their next steps. Whether planning for whole-class instruction or differentiation, formative assessment guides instructional decisions.

For example, several students who chose answer B explained that the Sun is a star and it is between the Earth and the Moon. The students are correct in recognizing the Sun is a star, but their explanation points out the need for further instruction that will help them understand the Sun is the only star in our solar system and the planets and Moons orbit around
the Sun. Some students mentioned a small star between the Earth and the Moon because “that is what it looks like when I see the Moon and sometimes a star is close to it.” I wonder whether some students’ ideas were influenced by picture books? I have even seen drawings in which a star is nestled within the curve of a crescent Moon, which means it would be in front of the Moon in relation one’s to view!

Students who chose B and D generally described small stars being “sprinkled” or spread out between the Earth and the Moon, because they could see little stars “all through the sky around the Moon.” Although further probing would be necessary, this may point out the need for instruction that would help students realize many of those stars are larger than our Sun, and all are much larger than our Moon. Because they are so far away, they look like tiny points of light. Furthermore, children’s picture books often make it look like the stars are “around the Moon.” Response E revealed two interesting ideas: (1) the notion that the stars are all “behind the Moon” and (2) the notion that stars are spread out between the planets and the rest of the solar system. Although they did not use the word, some responses seemed to indicate the idea of a galaxy without recognizing the stars in the galaxy are far away, outside of the solar system. For example, one student explained, “There are millions and millions of stars surrounding planets and everything way out far in the solar system.”

Examining the teacher notes for this probe reveals that even an interviewed high school student described stars as being dispersed within the realm of the solar system (Agan 2004). The teacher notes also point out the difficulty students have dealing with large magnitudes. Numbers like billions and trillions are incomprehensible to most children and even adults. If you drew a line on a whiteboard representing a billion miles and asked a student (or adult!) to quickly point out where a million miles would be on the line, many children will point to the midpoint of the line. The number that represents a million miles would actually be near the beginning of the line.

The point is that for assessment to be formative, teachers need to probe beyond the selected response. Multiple-choice items can be good assessments if well-designed. They can be even better assessments, especially for formative use, if students are asked to share their thinking in either written or oral form. These “enhanced multiple-choice” assessments provide opportunities to probe much deeper and uncover ideas that may serve to inform significant curricular and instructional decisions. One simple change you can make to your own selected-response-item assessments is to ask students to explain why they chose an answer. That simple inquiry into students’ thinking can provide you with a treasure trove of information to inform your teaching and promote learning. As a result of examining students’ ideas about “Emmy’s Moon and Stars,” maybe you will reconsider the efficacy of the solar system model activities you have been using. Perhaps the assessment results will help you think about new ways to help students model and conceptualize the solar system within part of the larger universe.

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References