Uncovering Student Ideas in Astronomy

45 NEW Formative Assessment Probes

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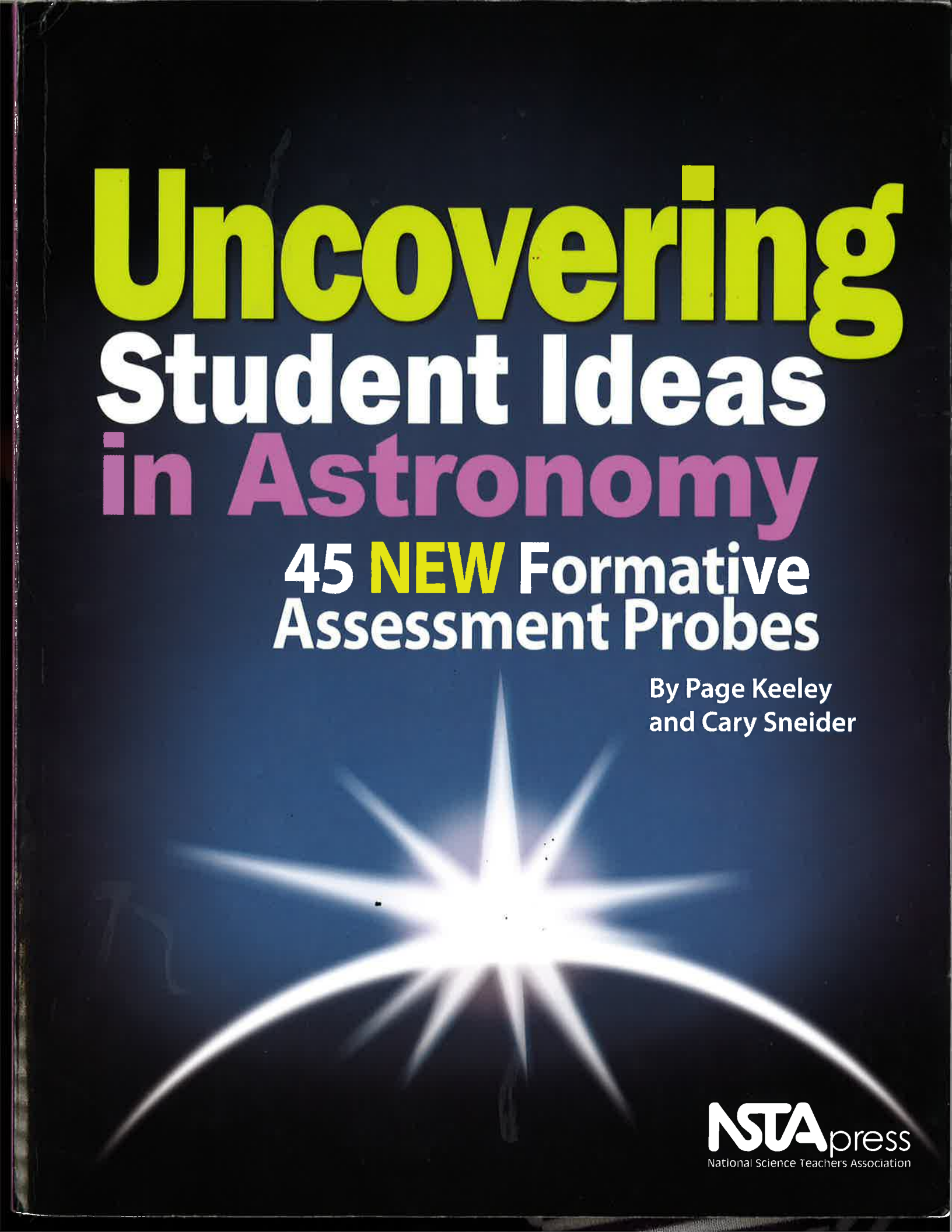

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Earth or Moon Shadow?

Two friends were looking at the Moon. Part of the Moon was visible to them. They wondered why they could only see part of the Moon. This is what they said:

Sally: "I think the part we can't see is the Moon's own shadow."

Enrique: "I think the Moon has moved into the Earth's shadow."

Circle the friend you agree with the most: Sally Enrique

Explain why you agree. _____

_____

_____

_____

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Earth or Moon Shadow?

Teacher Notes

Purpose

The purpose of this assessment probe is to elicit students' ideas about why the Moon appears to have different shapes at different times. The probe is designed to find out if students confuse the explanation for a lunar eclipse with the explanation for Moon phases.

Related Concepts

Moon: appearance, orbit, phase
Objects in the sky

Explanation

Sally has the best answer: "I think the part we can't see is the Moon's own shadow." Think of holding an orange next to a lamp in a darkened room: the part of the orange facing the lamp is brightly lit, but the part facing away from the lamp is dark. Enrique is expressing the common misconception that Moon phases are caused when the Moon enters the shadow of the Earth, which is an eclipse of the Moon. His erroneous view is supported by the observation that the shadow on a crescent Moon is curved, suggesting the Earth's shadow. However, at certain phases (first quarter and third quarter) there is a straight line between the light and dark parts of the Moon. If the Moon were entering Earth's shadow that line would always be curved due to the curved surface of the Earth.

Administering the Probe

This probe is best used with students in grades 5 and above. Make sure students know what is meant by "moving into Earth's shadow" (e.g., the Earth casts a shadow on the Moon) before asking students to respond. This probe is also appropriate for adults since many adults share Enrique's misconception.

Related Ideas in *Benchmarks for Science Literacy* (AAAS 2009)

K–2 The Universe

- The Moon looks a little different every day, but looks the same again about every four weeks.

6–8 The Earth

★ The Moon's orbit around the Earth once in about 28 days changes what part of the Moon is lighted by the Sun and how much of that part can be seen from the Earth—the phases of the Moon.

Related Ideas in *National Science Education Standards* (NRC 1996)

5–8 Earth in the Solar System

★ Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the Moon, and eclipses.

Related Research

- A research review of 27 studies about children's and adults' understanding of Moon phases and eclipses (Kavanagh, Agan, and Sneider 2005) found that a very common misconception is that Moon phases occur when the Moon enters the Earth's shadow. That is a correct explanation for a lunar eclipse, but not for Moon phases. Findings from studies that attempted to teach students of various ages about the cause of Moon phases indicated that instruction is likely to be effective only for students in grades 5 and above. Furthermore, a large percentage of adults, including many teachers, are unable to separate the explanations for Moon phases and eclipses, suggesting that high school and college students can also benefit from instruction on this topic (Kavanagh, Agan, and Sneider 2005).
- Dai (1991) presented a unit on Moon phases to two fifth-grade classes in Taiwan in which students observed the Moon in the sky for several days and nights, used physical models of the Earth-Sun-Moon system to reproduce the effects of phases and eclipses, and acted out a play that demonstrated the movements of the Earth, Sun, and Moon. She compared the results of the instruction with the results in two other fifth-grade classes who learned about Moon phases using a traditional textbook approach, and she found the activity-based method to be more effective. Nonetheless, explaining Moon phases from the space viewpoint of the Earth-Sun-Moon system remained difficult for students even after instruction.
- Barnett and Morran (2002) conducted an in-depth study of 17 fifth-grade students as they learned about Moon phases and eclipses through class discussion, large- and small-group activities, and work with three-dimensional models. The researchers found that instruction was effective for many, though not all, students and recommended that rather than viewing misconceptions as impediments to learning, students' existing frameworks should be used to provide opportunities to reflect on their evolving understandings as they continue to learn science.

★ Indicates a strong match between the ideas elicited by the probe and a national standard's learning goal.

Suggestions for Instruction and Assessment

- This probe can be combined with "Going Through a Phase" in *Uncovering Student Ideas in Science, Vol. 1: 25 Formative Assessment Probes* (Keeley, Eberle, and Farrin 2005) and "Lunar Eclipse" in *Uncovering Student Ideas in Science, Vol. 4: 25 New Formative Assessment Probes* (Keeley and Tugel 2009).
- The Moon is fascinating to young children, so the elementary years are a good time to help them become familiar with the Moon's monthly cycle of phases. However, few children at this age level have sufficient spatial visualization abilities to understand the causes of Moon phases. And while the concept of an eclipse is easier to understand, until students fully appreciate the Earth as a spherical body in space, these concepts will not make a lot of sense.
- In the upper elementary grades (3–5), students should spend at least a month making Moon observations, recording when they can see the Moon during the daytime and when they see the Moon at night and noting how the relative positions of the Sun and Moon in the sky correspond to changes in the Moon's apparent shape.
- Researchers have found that students in fifth grade and above can begin to understand Moon phases, although many students may continue to confuse the explanations of Moon phases and eclipses, even after observing and modeling the Moon's monthly cycle (Kavanagh, Agan, and Sneider 2005).
- By middle school the great majority of students will have the spatial visualization skills needed to understand solar and lunar eclipses as well as phases. However, it is important that they first be clear about the monthly cycle of phases, preferably through their own observations, and then have an opportunity to model phases in order to explain why they occur.
- It is best to model both phases and eclipses with a single bright bulb in a darkened room to represent the Sun and a ball for each child to hold, representing his or her personal Moon. The students can then see their model Moon go through an entire cycle of phases as they slowly move it in a circle around their heads. The students can also observe when the Moon goes into the Earth's shadow (that is, the shadow of each student's own head) and distinguish that eclipse of the Moon from phases, which occur throughout the Moon's entire orbit.
- At the high school level, it is a good idea to present this probe before beginning a unit on astronomy to find out if your students understand the basic mechanics of the solar system. If they do not, the activity described above to model Moon phases and eclipses will be appropriate.
- The University of Nebraska–Lincoln has a good simulation to address the concept of lunar phases: *http://astro.unl.edu/naap/lps/animations/lps.html*

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