Sizing Up the Moon

Have you ever looked up at the Moon and wondered how big it is? Put an X next to the thing you think is closest to the size of the Moon.

_____ penny

_____ baseball

_____ basketball

_____ chair

_____ car

_____ my school

_____ my city

_____ Earth

_____ the Sun

Explain your thinking. How did you decide how big the Moon is?

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Teacher Notes

Purpose

The purpose of this assessment probe is to elicit students' ideas about the size of the Moon. The probe is designed to find out if students understand the idea that something huge can appear to be small if we see it from a great distance, and and to find out if they are able to apply that idea to realizing that the Moon is much bigger than it appears to be.

Related Concepts

Apparent vs. actual size
Moon: appearance, size

Explanation

The best answer is the Earth. Although the Moon may appear as small as a coin or baseball in the sky, that is because it is very far away. Things that look small in the night sky can actually be quite large. Of all the things on the list, the Moon is closest to the size of the Earth, although its diameter is only about 25% that of the Earth and only about 2% of the volume of the Earth.

Administering the Probe

This probe is best used with elementary students. For students in grades K–2 the probe can be presented verbally. For older students the probe can be extended by asking them to think about how they could measure the size of the Moon.

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

3–5 The Universe

- Stars are like the Sun, some being smaller and some larger, but so far away that they look like points of light.

3–5 Shapes

- Scale drawings show shapes and compare locations of things very different in size.

6–8 Shapes

- The scale chosen for a graph or drawing makes a big difference in how useful it is.

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

K–4 Objects in the Sky

- The Sun, Moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described.

Related Research

- The age at which children are able to distinguish between how big something looks versus how big it really is has been of interest for more than half a century. The famous Swiss psychologist Jean Piaget reported that prior to about five years old few students are able to recognize that an object's actual size does not change when it is moved farther away. He called this ability "conservation of size," analogous to other conservation abilities (e.g., number, mass, liquid amount) that students develop as they mature (Piaget and Szeminska, 1952).
- Other psychologists confirmed Piaget's findings (Braine and Shanks 1965) and extended them. Rapoport (1967), for example, found that it wasn't until children were about nine years old that they could clearly and consciously distinguish between the actual and apparent size of an object.
- Tronick and Hershenson (1979) found that task difficulty also made a difference in whether or not a child was able to distinguish between apparent and actual size. For example, distinctions were easier when comparing a nearby object with an identical object just a few feet away, than when one object is much farther away (such as the Moon).
- Flavell (1986) confirmed earlier findings and conceived of the insight that what makes a difference in a child's ability to distinguish "real" from "apparent" is a theory of mind—that the child realizes that different people might see the same object in different ways. He noted that while some children could solve a simple task of this sort, it is not until they are 11 to 12 years old that they have a "substantial body of rich, readily available, and explicit knowledge in this area."
- This concept of judging relative size continues to be a rich area for research. Recently, Miller and Brewer (2010) studied the strategies that children in grades 1–3 used to judge the size of a disc at two different distances (6.1 meters and 61 meters). Some children were able to report the strategy they used; others could not. Students with higher visual spatial reasoning ability were more likely to be able to report on the strategies they used.

Suggestions for Instruction and Assessment

- In the primary grades (K–2) the challenge is for students to understand that things are not always as they seem. You might take the children outdoors to look at telephone poles and ask the students to compare how big the poles nearby *appear* compared with those farther down the street. The students can use their fingers held at arm's length to "measure" how big the different telephone poles appear to be. Then ask the students: "Do the closer telephone poles just look bigger, or are they really bigger?" This concept lays the groundwork for later under-

standing of the truly astronomical scale of the Moon and other planets. During the upper elementary grades (3–5), when students come to understand the Earth as an amazingly huge ball in space, they can begin to appreciate how large the Sun and Moon must be.

- Consider changing the context by asking students if the Sun is bigger than or smaller than the stars they see in the sky. This question reveals whether they recognize that a large object very far away can appear to be much smaller than a smaller object closer to the observer. The Sun, a medium-size star, is smaller than many large stars in the night sky.
- Consider extending this probe by asking upper elementary or middle school students how they would measure the size of the Moon. While elementary students may not have the mathematics knowledge of geometry to come up with the solution, the question elicits creative thinking. After middle school students have discussed their ideas about how to measure the size of the Moon, it is possible to provide some basic geometry activities where they can begin to learn how it was actually done in the days before space travel. *Project Earth Science: Astronomy* by Sean Smith (2001) suggests an activity called "It's Only a Paper Moon," in which students use similar triangles to find the diameter of the Moon, given its distance.
- In high school students have the mathematical background to figure out how to measure the size of the Moon. In order to measure the diameter of the Moon it is first necessary to measure its distance from Earth. Astronomy textbooks such as Project STAR (Coyle et al. 1993) provides several different ways to measure the Moon's distance (e.g., the parallax method, in which the Moon's position against background stars is observed from two different positions on Earth; and bouncing a radar pulse off the Moon and measuring the amount of time it takes for the beam to come back to the source).

References

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