

Phenomena to help Elementary School Students Understand that the Earth is Spherical

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Abstract

Much of science involves finding patterns in observations and explaining them in terms of a small number of principles or ideas. For students to appreciate how science works, they need to have a sense of the range of observations (phenomena) that are used to form the patterns and the helpfulness of the principles or ideas in explaining them. Project 2061's evaluations of science textbooks revealed that textbooks rarely engaged students with phenomena relevant to important science ideas, rarely included phenomena that directly address the often incorrect ideas that students may already have, and rarely guided students in reconciling phenomena with scientifically accepted ideas (Kesidou & Roseman, 2002; Stern & Roseman, 2004; American Association for the Advancement of Science [AAAS], 2002, 2005). In response to these deficiencies, Project 2061 and other CCMS researchers are identifying phenomena that could be used to support the teaching and learning of ideas recommended in *Benchmarks for Science Literacy* (AAAS, 1993) and in the *National Science Education Standards* (National Research Council, 1996). This poster describes three phenomena that could be used to help students understand that the Earth is spherical in shape and one phenomena that most likely would not be useful to help elementary school students.

Key Idea






The Earth is approximately spherical in shape. (Based on benchmark 4B/E2a)

What Students are Expected to Know

The expectation is that students will know that:

- The Earth is a sphere.
- The Earth's large size (relative to us) makes it look flat as we stand on the surface.
- People live all over the surface of the Earth (including the southern hemisphere) without any risk of "falling off." Their feet are on the ground and when they drop something, it falls to the ground.
- There is no universal "up" and "down." What we think of as "up" and "down" is really "toward the Earth" and "away from the Earth."

Ideas Students Have

- The Earth is flat. 
- There are two Earth's, a flat one that people live on and a spherical one in space. 
- The Earth is spherical, but people live on a flat surface inside it. 
- The Earth is spherical, but people live only on the surface of the top hemisphere. 
- The Earth is spherical, and people live all over the surface. 

References:

- American Association for the Advancement of Science. (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press.
- American Association for the Advancement of Science. (2002). Middle grades science textbooks: A benchmarks-based evaluation. Retrieved on 06/19/2007, from <http://www.project2061.org/publications/textbookingsci/reportindex.htm>.
- American Association for the Advancement of Science. (2005). High school biology textbooks: A benchmarks-based evaluation. Retrieved on 06/19/2007, from <http://www.project2061.org/publications/textbookingsci/reportindex.htm>.
- Kesidou, S. & Roseman, J. E. (2002). How Well Do Middle School Science Programs Measure Up? Findings from Project 2061's Curriculum Review. *Journal of Research in Science Teaching*, 39 (6), 522-549.
- National Research Council. (1996). *National Science Education Standards*. Washington, DC: National Academy Press.
- Stern, L., & Roseman, J. E. (2004). Can middle-school science textbooks help students learn important ideas? Findings from Project 2061's curriculum evaluation study. *Life science. Journal of Research in Science Teaching*, 41(6), 538-568.

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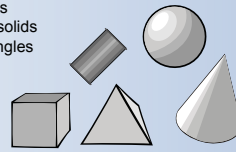
The Earth Looks Like a Circle from Different Places in Space

- Students should observe that the photographs all show a circular outline even though they contain different landmarks.

- Students will need to infer that the photographs were taken of different parts of the Earth. Comparing the photos to a globe may help them confirm that a globe is an accurate representation of the Earth.



- To appreciate that only a spherically shaped Earth would always give photographs of different parts of the earth as circles, students could take photos of variously shaped solids (including a sphere, cylinder, and cube) from different angles and compare them.

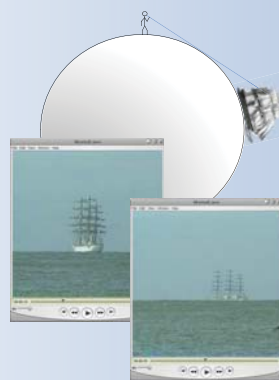


Thinking Through What Observations Are Needed

One photo is not enough to show that the Earth is spherical because a disk or cylinder can look like a circle when viewed from a specific angle.

Ship Disappearing at the Horizon

- Students should observe that when a ship sails away, the ship's mast remains visible after the bottom part of the ship has disappeared.
- The bottom part of the ship disappears because the Earth is curved and that the ship is far enough around the Earth that the bottom part is hidden by the Earth. If the Earth were flat, the entire ship would always be visible.
- Students can model this phenomenon by comparing photos they take of a model ship receding into the distance on a flat versus a curved surface.



Describing What is Needed Can Lead to Finding It

When this set of phenomena was first presented at the 2005 Knowledge Sharing Institute, we were unaware of any actual video recordings of ships on the horizon. After that presentation, curriculum developers from the Lawrence Hall of Science informed us that they had captured the needed images. We hope that future wish lists of phenomena will unearth hidden treasures already in existence and prompt developers to produce needed resources.

Zoom Out from a Place on the Earth



- Students should observe a series of photos or a video that show a place on the Earth at progressively larger scales.
- At the smallest scale, buildings or local landmarks should be recognizable. The largest scale should show the Earth as a sphere.
- These images can help students link their experiences on the Earth's surface with the idea that the Earth is a sphere.

Students' Ideas Guide the Selection Process



The need for experiences with phenomena like this became clear through efforts to address the commonly held idea that there are two Earth's, a flat one that we live on and a spherical one in space. Viewing a video like this, or a satellite imagery program like Google Earth, can help students see that the ground they stand on is part of a spherical Earth.

Earth's Shadow During a Lunar Eclipse



- Students should observe that during lunar eclipses, the edge of the Earth's shadow is always part of a circle.
- While this observation is consistent with the earth being spherical in shape, it is also consistent with the earth having other shapes, such as a plate, cylinder, or ellipsoid.
- To interpret these photographs, students would need to know how shadows are formed, how eclipses occur, and how multiple exposure photographs are made.

Some Phenomena Are Not Appropriate

While the curvature of the Earth's shadow on the moon during an eclipse was one of the earliest clues the ancients had of the spherical shape of the Earth, it is far from certain that this phenomenon will be helpful to elementary school students.

Considering all the knowledge that is needed, along with the fact that the observation is consistent with several possible shapes, we do not recommend this phenomenon for use with elementary school students.