Using Phenomena to Learn about Seasons in the Science Classroom

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Abstract

In the spring of 2007, I utilized the LHS-GEMS curriculum *The Real Reasons for Seasons*, supplemented with additional resources. I carefully considered the use of representations and the use of phenomena in my instructional choices. I found my use of phenomena to be critical, but difficult to administer. This account serves to emphasize the aid needed to ensure that teachers can effectively include phenomena in instruction.

These Key Ideas are based on benchmarks that were developed for the Weather and Climate Map in the *Atlas of Science Literacy*, Volume 2. Key Ideas 1-3 are derived from Benchmark 4B/M12. Key Ideas 4-7 are derived from Benchmark 4B/M13*. Key Ideas 8-12 are derived from Benchmark 4B/H3**, which is based on a middle school benchmark (4B/M4) in the 1993 edition of *Benchmark for Science Literacy*.**

Key Idea #1 (Daily Temperature Cycles): The temperature of any location on the Earth's surface tends to rise and fall in a somewhat predictable pattern over the course of a day.

Key Idea #2 (Yearly Temperature Cycles): The temperature of any location on the Earth's surface tends to rise and fall in a somewhat predictable cycle over the course of a year.

Key Idea #3 (Factors Affecting Variation in Cycles): The yearly temperature cycle of a location depends on how far north or south of the equator it is, how high it is, and how near to oceans it is.

Key Idea #4 (Yearly Amount of Daylight Cycles): The number of hours of daytime or nighttime in a place on the Earth's surface varies in a predictable pattern over the course of a year that depends upon how far north or south of the equator the place is.

Key Idea #5 (Yearly Cycles of Sun's Path): The path the sun appears to take across the sky when viewed from a particular place on the surface of the Earth shifts higher and lower over the course of the year. The path also appears higher or lower from different places on the surface of the Earth depending on how far north or south of the equator the place is.

Key Idea #6 (Sun's Height Affects its Intensity): The intensity of sunlight striking a place on the surface of the Earth varies depending on how high the sun is in the sky. Therefore the intensity depends upon what time of day it is, what time of year it is, and on how far north or south of the equator the place is.

Key Idea #7 (Effect of Sunlight on Temperature): The temperature of a location on the surface of the Earth depends upon the number of hours of sunlight and the intensity of that sunlight.

Key Idea #8 (Constant Direction of Axis of Earth's Orbit): The axis of the Earth's rotation is tilted relative to the plane of the Earth's yearly orbit around the sun. As the Earth orbits the sun, the axis remains pointed to the same place in space.

Key Idea #9 (Earth's Orientation affects Amount of Daylight): The difference in how much of the day is daytime and how much is nighttime at a place on the surface of the Earth depends upon where the Earth is in its yearly orbit around the sun and how far the place is from the equator.

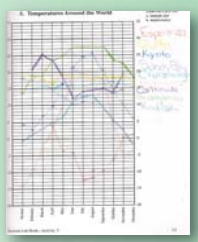
Key Idea #10 (Sunlight on a Spherical Earth): Because the Earth is a sphere, at any particular time, light from the sun strikes different parts of the Earth at different angles and therefore the intensity of light striking the surface of the Earth is different in different places.

Key Idea #11 (Earth's Orientation Affects Intensity of Light): The intensity of sunlight striking a place on the surface of the Earth depends upon where the Earth is in its yearly orbit around the sun and how far the place is from the equator. These variations of intensity as the Earth orbits the sun explain the seasonal variations in temperatures at different places on the surface of the Earth.

Key Idea #12 (Tilted Axis During Orbit Causes Seasons): The seasonal variations in temperatures at different places on the surface of the Earth are explained by the differential heating of the Earth's surface as it rotates on an axis that is tilted relative to the plane of its orbit around the sun.

Phenomena

- Students recorded the path of the sun in the sky tracked onto a "Celestial Hemisphere" (Project STAR materials). The record of this data will help students to see that the path the Sun appears to take across the sky shifts higher or lower over the course of the year. (from Benchmark 4B/M13** Key Idea B)
- Students analyzed changes in light intensity as the angle changes between paper and flashlight (LHS-GEMS). This phenomena serves as evidence that the intensity of sunlight striking a place on the surface of the Earth varies depending on how high the sun is in the sky. (from Benchmark 4B.M13** Key Idea C)
- Students plotted and examined graphs of yearly temperature changes for different locations on Earth (LHS-GEMS) This allows students to see that the temperature of any location on the Earth's surface tends to rise and fall in a somewhat predictable cycle over the course of a year; The yearly temperature cycle of a location depends on how far north or south of the equator it is, how high it is, and how near the ocean it is.(from Benchmark 4B/M12** Key Ideas B & C)



- Students plotted and examined graphs of daylight hour changes for different locations on Earth (LHS-GEMS) This allows students to see that the number of hours of daytime or nighttime a location on Earth's surface gets varies in a predictable pattern over the course of the year that depends upon how far north or south of the equator they are. (from Benchmark 4B/M13** Key Idea A)
- Students watched a Teacher's Domain video clip of the angle of sunrise and sunset on the horizon. This video clip assists with students' awareness of the Sun's path across the sky, supporting the idea that the path that the Sun appears to take across the sky shifts higher or lower over the course of the year. (from Benchmark 4B/M13** Key Idea B)

Representations

- Students measured changing light intensity on a globe as the globe is moved to simulate an orbit around a light bulb (LHS-GEMS). This supports students' understanding that the intensity of the sunlight striking a place on the surface of the Earth varies depending on how high the sun is in the sky. (from Benchmark 4B.M3** Key Idea C)
- Students measured changing amounts of light on the latitude lines of a globe as the globe is moved to simulate an orbit around a light bulb (unpublished teacher materials). This representation allowed students to calculate the number of hours of daytime or nighttime at various locations on Earth's surface and discover the predictable pattern depending upon how far north or south of the equator they are. (from Benchmark 4B/M13** Key Idea A)

- Students utilized scale models of the Earth-Sun system: size scales marked on paper; distance scales marked on string and marked on the classroom floor, orbital shapes drawn in student handouts; orientation models marked with the location of Polaris, solstice and equinox dates posted on the classroom walls (LHS-GEMS & unpublished teacher materials). These representations supported the three-dimensional model of the Earth/Sun system, including the knowledge that the axis of the Earth's rotation is tilted relative to the plane of the Earth's yearly orbit around the sun. As the Earth orbits the sun, the axis remains pointed to the same place in space. (from Benchmark 4B/M4 Key Idea A)

Notes on Phenomena and Representations

- Phenomena: Many students expressed surprise with the emerging pattern of temperature and daylight hours at different Earth locations.
- Representations: The orientation models integrated with the representation of daylight hours (unpublished teacher materials) seemed to most effectively impact student understanding.
- Integrating Phenomena with Representations: Taking the representations of the Sun-Earth system and applying them to the real phenomenon of the Sun's path in the sky and the angle of sunrise and sunset on the horizon proved to be quite challenging. Many students developed an understanding of the representation without a clear accounting of the phenomena.

Meeting Learning Goals and Classroom Learning Target

- Currently, only preliminary analysis of pre- and post-instruction assessments and videos has occurred. These assessment items were adapted from LHS-GEMS, SCALE Up, and unpublished teacher materials. Additional classroom assessments include formative measures and a final synthesis project in which students created unique children's books to demonstrate their learning.
- The preliminary analysis of these assessment materials suggests that a large majority of 8th grade students in my classroom succeeded in meeting most learning goals, including the overall classroom learning target to explain the cause of seasonal change.

Conclusions

- This analysis of the use of phenomena and representations when teaching seasonal change serves to illustrate how much consideration is needed to effectively support student understanding for just one topic in a science classroom. Representations may readily support student learning, but may not allow for an explanation of observed phenomena. Similarly, a teacher may easily neglect phenomena because their analysis requires a more complex explanation of natural events.
- Bringing phenomena into the classroom can be a difficult task; teachers should be aware of its necessity.
- Teachers need support to ensure that their students are exposed to phenomena that provide understandable evidence for scientific knowledge.