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 use phenomena in instruction.

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 C)
- 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 to 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 varies with the location of 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 sunshine 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 place 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 (unpublished teacher materials). 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 allows 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/M13** 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-S-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.