Connecting Three-Dimensional Learning to Upcoming Out-of-this-World Phenomena

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October 14, 2023 Annular Solar Eclipse
April 8, 2024 Total Solar Eclipse
1. Aligned with the Framework for K-12 Science Education and the Next Generation Science Standards (NGSS)

2. Uses the BSCS 5E approach to organizing student experience around each topic – Engage, Explore, Explain, Elaborate, Evaluate

3. Indicates connections to the language arts and mathematics standards in the Common Core State Standards

4. Includes resources to provide interdisciplinary experiences.
Incorporates the three key dimensions of effective science learning from the Framework for K-12 Science Education.

1. **Disciplinary Core Ideas** (DCIs) – The most important science and engineering ideas that students should know.

2. **Science and Engineering Practices** (SEPs) – Behaviors that students need to investigate and build models and theories about the natural world.

3. **Crosscutting Concepts** (CCCs) – Science concepts that have application across all domains of science.
Provides Examples of Three-Dimensional Learning

- Interweaves the dimensions, so students see them as a connected whole.

- Not every individual activity lends itself to incorporating all three dimensions.

- It is only when you look at a sequence of learning experiences that one can identify effective ways to incorporate 3D Learning.
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March 22

gnome = 22cm tall
(standard time)

[Diagram of a circle with a compass orientation]
Modeling Relationship Between Earth and Sun

Students now develop their modeling skills using a simple model of the Earth and Sun
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Gnomon = 22 cm tall (standard time)
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SHEET 1: IMAGES OF THE SUN FROM THE SOLAR DYNAMICS OBSERVATORY IN MAY 2014

May 8, 2014

May 11, 2014
DCI Related to Solar and Lunar Eclipses

Performance Expectation associated with MS-ESS1.A

*Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.*
Students also engage with the following key Scientific Practices

- **Analyze and interpret data** during their efforts to predict the order of the lunar phases and then as they make regular observations of the Moon in the sky.

- **Use a model of the Earth-Moon-Sun system** to describe the relationship between them and to help them develop an understanding of what causes the Moon’s phases and eclipses.

- **Engage in argumentation** based on evidence as they compare their predictions for the order of lunar photographs and their daily observations of the Moon.
Students also engage with the following Crosscutting Concepts

- **Patterns** observed in the experiences can identify cause-and-effect relationships, as seen in how the relative position of the Earth, Moon and Sun produce the Moon’s phases.

- **Science assumes that objects and events in natural systems occur in consistent patterns** that are understandable through measurement and observation, as demonstrated by observations of the Moon and Sun leading to an understanding of when solar and lunar eclipses occur.

- **System models** provide an opportunity for understanding and testing ideas, as seen in the student’s head, Styrofoam ball and light bulb model of the Earth- Moon-Sun system.
Six Lunar Photographs, Set 2

Source:
Fred Espenak
# Lunar Observing Record Chart

<table>
<thead>
<tr>
<th>Sunday</th>
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Location

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Modeling Lunar Phases and Eclipses

Students now develop their modeling skills using a simple model of the Earth and Sun
Modeling Lunar Phases and Eclipses

We now add a model Moon to expand and deepen their understanding of the relevant DCI and continue their practice using models.
Modeling Lunar Phases and Eclipses

Students then explore moving their model Moon in its orbit to determine what phase the Moon has to be in to block the Sun’s light from reaching the Earth (a solar eclipse) and when the Earth can block the Sun’s light from getting to the Moon (a lunar eclipse)
More Questions Than Answers

• If a full Moon and new Moon happen every month, shouldn’t we have eclipses every month?

• Why was the 2017 total solar eclipse the first one in the US in almost 40 years?

• Why do people spend thousands of dollars and travel thousands of miles to see a solar eclipse, but don’t travel to see a lunar eclipse?
Experience 4.6
• One Hula Hoop is the orbit of the Moon around the Earth.
• The other Hula Hoop is the apparent path of the Sun around the Earth.
• Normally the Moon and Sun are not lined up to produce an eclipse.
• Eclipses only occur when Moon and Sun are at crossing points.
• Solar and lunar eclipses happen every six months (separated by two weeks).

Experience 4.7
• Uses the Earth-Sun-Moon model to show only a small area on the Earth sees a solar eclipse.
• While half the Earth gets to see a lunar eclipse.
• Thus, people travel thousands of miles to see a total solar eclipse.
Your Students Will Now Be All Set for the October 14, 2023 Annular Solar Eclipse
AND the
April 8, 2024 Total Solar Eclipse
I wish you clear skies and great solar viewing.