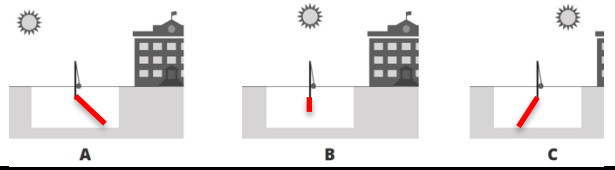
# Pattern Analysis of Student Thinking (PAST)
# 5-ESS1-2 - Shadow Patterns Assessment Task

**PE - Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.**

**DCI – Earth and the Solar System:**
• The orbits of Earth around the Sun and of the Moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the Sun, Moon, and stars at different times of the day, month, and year.

## TASK 1 – *Students explain how the Sun's position is related to shadows on the playground.*

| Purpose | Student Response Themes | Examples of Student Responses | Possible Teacher Instructional Moves |
|---|---|---|---|
| This task is designed to engage students in a familiar phenomenon and to elicit thinking about how shadows are related to the position of the Sun in the sky relative to the object casting the shadow. Students should be able to identify patterns that can be used to describe the cause and effect relationship between the Sun and shadow direction. | Student drawings should show the shadow of the pole in the approximate positions of the drawing to the right. |  | |
| | **Question 1**<br>The Sun's position in the sky determines shadow direction. Shadows are cast on the opposite side from the way the Sun's rays are directed. | • *Shadows happen when the pole blocks light from the Sun as it moves.*<br>• *Shadows are longer when the Sun is low and shorter when the Sun is high.*<br>• *They look different because the Sun is hitting from a different angle.*<br>• *The shadow is on the other side from the Sun.* | If students do not draw appropriate patterns on the images, they may benefit from more experience with looking at their own shadows over the course of a day. They can also look at shadows of other objects outdoors to determine how they fall in relation to the Sun's location.<br><br>Students can also collect shadow direction data using a Sundial, tetherball pole, or flashlight and toothpick/clay model. |
| | Earth's rotation causes differences in shadows because it changes the Sun's position overhead. | • *The rotation of the Earth is what causes the shadows to be at different places and lengths.*<br>• *The spin of the Earth makes it look like the Sun is moving. When the Sun is moving, the shadows move to the opposite side from the Sun.* | |

**Focus SEP/CCC:** Students are developing and using a model to support an explanation about the cause and effect relationship of the position of the Sun in the sky and the direction and length of shadows.



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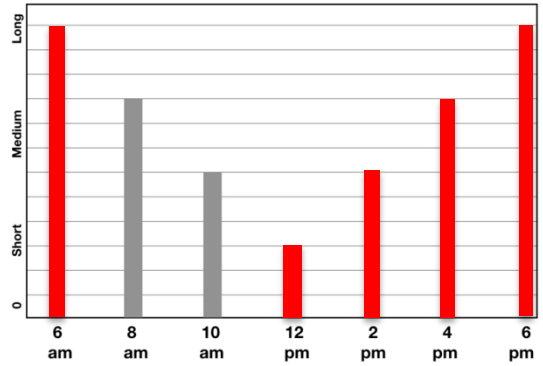
## TASK 2 – *Students explain how the time of day is related to the length of shadows.*

<table>
<tr><th>Purpose</th><th>Student Response Themes</th><th>Examples of Student Responses</th><th>Possible Teacher Instructional Moves</th></tr>
<tr><td rowspan="3">This task is designed to engage students in representing data in graphical form to show patterns that describe a phenomenon. When given two data points showing shadow length at different times of the day, students should be able to predict the pattern of shadow length at other times of the day based on their understanding of the relationship between the Sun's position and the length of shadows. They should construct a written explanation to describe the pattern of their data and how it connects to the position of the Sun relative to Earth's rotation.</td><td>The graph should be completed with bars showing a decrease from 6 am to noon and then an increase after noon as shown on the graphic to the right.</td><td> 
</td><td></td></tr>
<tr><td>Question 2<br>Shadows are long in the morning, get shorter until noon, and then get longer.</td><td>• It is longer at 6am then shortest at 12pm then it is as long as it was at 6am at 6pm.<br>• The bars should be longest at 6am, get shorter until noon and then longer.</td><td rowspan="2">If students do not draw the correct pattern, it may be that they are having trouble transferring observed patterns into graphic form. Students can be provided with further exploration such as collecting shadow length data from objects outdoors, including their own shadow. They should measure and graph the data they collect. They should see the same pattern they were asked to draw in this task. Students can also look at the length of shadows created from a flashlight or other light sources to see how the orientation of the light source changes the amount of light that is blocked by the object.</td></tr>
<tr><td>Question 3<br>Earth's rotation causes the length of the shadow to change because it changes the relative position of the Sun from one side, to overhead, and then to the other side.</td><td>• The Sun faces you in a different way as it moves.<br>• When the Sun is low it cannot pass through a solid object, creating a longer shadow. When the Sun is high, there is not much to see, which makes a shorter shadow.<br>• The Earth is spinning and is changing the effect of the Sun on the object's shadow.<br>• Because we move when earth moves which makes the Sun look like it moves and changes the shadows.</td></tr>
</table>

**Focus SEP/CCC:** Students are representing data in table to predict patterns that show the relationship of shadow length to the time of day and position of the Sun.



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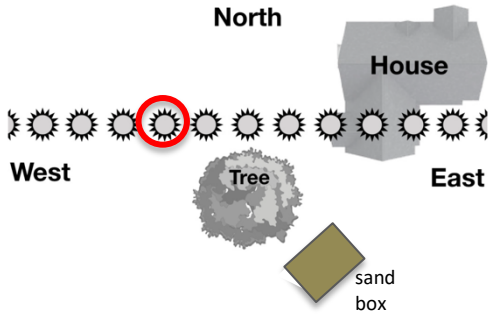
## TASK 3 – Students *Sandbox Placement*

| Purpose | Student Response Themes | Examples of Student Responses | Possible Teacher Instructional Moves |
|---|---|---|---|
| This task was designed to engage students in making predictions and designing solutions based on the observable relationship between the Sun and shadow length and direction. Students should be able to locate the correct position of the Sun at a particular time of the day. Students should then be able to propose a solution about where to place a sandbox based on their understanding of the movement of the Sun across the sky and the effect this has on shadow length and direction. | Students should circle a Sun to the left of the tree to show that it has moved from east to west. The sand box should be placed on the opposite side of the tree from the Sun's location. An example is shown on the right. |  | |
| | The Sun rises in the east and its highest in the sky at noon. | • *Because 12:00 the Sun is in the middle so I just started counting the Suns, but 2:00 pm is on the left so that is how I figured it out.* | This is an engineering application that uses a scientific concept to make a decision about where to build a structure. Students should be able to justify their decision with evidence from the previous tasks. Other applications of this type that can be explored are Sun umbrellas, planting shade trees, or placement of solar panels. |
| | Shadows fall on the opposite side from the Sun as its position changes from east to west. | • *The tree would block the Sun and create shade in that spot.*<br>• *The shadow would be there because the Sun would be directly across from the tree and the tree is blocking the Sunlight from making it to the ground.* | |

**Focus SEP/CCC:** Students are developing a model to describe, predict, and explain the pattern of shadows caused by the relative position of the Sun in the Sky in order to design a solution for placement of the sandbox.



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