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Caitlin M. Hallam
Coastal Carolina University, cmhallam@coastal.edu

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Why do Shadows Change Throughout the Day?

By

Caitlin Hallam

Elementary Education

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Louis E. Keiner
Director of Honors
HTC Honors College

Catherine Scott
Assistant Dean
Foundations, Curriculum, and Instruction
Spadoni College of Education and Social
Sciences

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Introduction

The *Next Generation Science Standards* (NGSS Lead States, 2013) allow educators to create meaningful and stimulating science experiences for students. There is a focus on solar systems and space systems in fifth grade which enables teachers to be creative when teaching about these topics. The focus of the science standards in fifth grade is the representation of space systems in everyday life: “Standard 5-ESS1-2. 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” (NGSS Lead States, 2013). This standard’s three indicators focus on gravitational pull, star brightness, and shadows. Educators can get creative with these indicators through the use of observations and experiments.

In this lesson, we will explain how the 5E learning model will be used for a lesson about shadows. The NGSS calls for fifth grade students to be able to graphically display patterns of shadows that occur during the day and at night. The crosscutting concept that is utilized in this lesson is *patterns* which requires students to “sort, classify, communicate, and analyze natural rates of change” of shadows (NGSS Lead States, 2013). Students will explore this concept by answering the question: Why do the positions of shadows change throughout the day?

Engage

This lesson began with a brief video clip from *Peep and the Big Wide World*, an animated show supported by the National Science Foundation and distributed by PBS Kids. In the clip (<https://youtu.be/Ty0C8mH4Jy8>), three bird friends learn that they are being chased by shadows. They end up running into a cat who teases them about them running from shadows.

Students will think it is funny that the Peep and friends run into the cat at the end of the clip and scare him by using their shadows.

The video clip is a great way to call attention to the fact that shadows are always changing. Depending on where the bird was and the time of day, the shadow would be in a different location. It allows students to begin thinking about why the shadow was following the birds, and then all of the sudden, the shadows were gone. The video clip can help the students begin thinking about how the positions of the shadows were changing. After the video, the students used what they learned from the video to answer the question, “Do shadows change positions? Why or why not?”

Students used a whiteboard and marker to write down what they knew about shadows using prior knowledge and the video clip. Next, students were paired up to discuss their ideas with a peer, while the teacher walked around to listen to conversations and initial thoughts. After, the students shared their ideas with the class, whose answers depended on their previous observations. Some students believe that shadows do not change positions because they went outside one day and noticed that their shadow was always behind them, while another student said that their shadow was on the side of them. Other students who said “yes” thought that their shadows changed positions because sometimes the shadows are in front of them and behind them some time later.

Explore

Once students began thinking about the changing in the positions of shadows, students were ready to begin their explorations. Students were then told that they would observe the ways in which shadows changed as a light shined on an object (See Materials List). Working with their table partners, each group of students built a tower using two unifix cubes to represent a

person. Students were also provided with a paper circle that they drew a smile on and taped it to the tower. The direction that the smile was facing was the front of the person. The teacher provided each group a lamp without a shade to use for their investigation to represent the sun, and an inflatable beach ball to represent the earth. The class discussed how in reality, a person would not be so visible on the Earth given scale and size, but that they were using the unifix cubes for illustrative purposes only. Students positioned their light so that it was steady on the table, and turned it on so that the lightbulb was lit. They were reminded not to touch the lightbulb, as it would get warm. Next, each group was supplied with tape to secure their person to the beach ball. Students placed the person just above the middle of the ball, so as to represent their current location slightly above the equator. Students took turns rotating the beach ball on it's own axis to watch what happened to the "person's" shadow as it changed location and position from the sun. It is important to note that while the earth rotates both on its own axis and around the sun, the students were instructed to focus on the change in shadows and to remain stationary, as seasons would be covered in future lessons.

INSERT MATERIALS LIST HERE

Students were given twenty minutes to investigate, with one student rotating the ball on it's axis, one student sketching the shadow, and two people working together to record the group's explanation of why the shadows changed when the earth rotated. As the students began their investigation, each group was responsible for recording their observations. Students identified and explained what happened to the position of the shadows as the earth rotated. They conveyed this information through drawings of their observations (See Figure 1 for data collection sheet).

INSERT FIGURE 1 HERE

Explain

Once the students completed their initial observations and experiments, the class came back together to share their findings. Students began to realize that the changes in position of the earth as it rotated resulted in shadows changing positions. Most students were sharing similar observations. They noticed that their shadows would change as the Earth rotated. Students were able to make the connection that when the person rotates away or towards the sun, shadows elongate or shrink. With the light at one location, students were able to conclude that the earth moves throughout the day and while the earth moves, shadows change positions. By the end of their exploration, students were connecting this experiment to the real-world science of shadows. Students will learn lesson-specific terms to complete worksheets and use in the future. They will learn the terms: rotation, revolution, axis, and hemisphere. These words will help them formulate knowledgeable statements about shadows.

Elaborate

Next, students were taken outside instead of completing morning work to observe their own shadows. Each student worked with a partner to select a location on the sidewalk. Next, students were asked to outline their partner's shadow on the ground with sidewalk chalk, and to sketch it in their notebook with the time and date recorded. Once each pair has drew their shadows, the class headed back inside to discuss what they noticed about their shadows. The students noticed that their shadows were all positioned similarly and had similar lengths. Students will repeat these steps throughout the day to see different results as the earth rotates. They will go outside after lunch, and then again before dismissal.

Following the trips outside, students had discussion using the terms that they learned in the Explain stage. The students used their new findings to elaborate on their knowledge of

shadows changing positions. Students were finding that as the earth rotated, the length of their shadows changed. In the morning, they had really long shadows, but towards the afternoon, their shadows seemed to be shrinking. After discussing their new findings, the class will line up once again to make their way outside with their same notebook, pencil, and partner. This time, they will draw their observations and write down differences that they noticed in the position of their shadows. They will work to answer: Is the shadow still facing the same direction? How do you know? What is different about the shadow? This will help them to use the knowledge they have gained thus far and elaborate on the original question.

Evaluate

During the final stage of the 5E learning cycle, students will take time to reflect on the original question that they have been working to answer. Now that they have compiled evidence to answer the question, students will figure out how the rotation of the earth affects the positions of shadows. Based on the collection of evidence, students will know that the positions of shadows change. They can look one way in the afternoon, and look different by the end of the day.

Students will write a reflection about how they know that the rotation of the earth affects the positions of shadows. They will write one to two paragraphs explaining how they know that their answer is correct and what evidence they used to come to that conclusion. Students should reference the observations that they made during the Elaboration and Exploration stages. They will also need to use at least three lesson-specific vocabulary words that they discussed during the explanation stage to form a clear and concise explanation that would also answer the original question (See Figure 2 for rubric).

INSERT FIGURE 2 HERE

For the end

This lesson is able to conform to standards for lower grade levels as well as upper grade levels. The lesson could always be modified to fit the needs of all students. Every student can go outside to explore their shadows changing, but the written assignments can be switched depending on the exceptionality of the children. In younger grades, the responses and discussions could be altogether instead of partnering students off and having small group discussions. In upper grade levels, students can complete each task individually or with one partner rather than using small groups, although some educators might find it necessary to get a discussion about this topic flowing.

The lesson is flexible enough to meet the needs of all students. For example, fonts can be enlarged and colors can be changed, online resources can have the ability to translate or read themselves aloud. Students can request printed copies of online materials as well as being able to use technology to complete each assignment. Educators can find most resources needed for students on the internet, and many times text-to-speech extensions are free, as are translation applications.

With the flexibility of this lesson, students will be able to leave the class with enough knowledge about shadows to explain to anyone why they change shape and direction throughout the day. The tasks are engaging for students while still allowing them to be the discoverers of knowledge. Students will leave the science class with new vocabulary and a new understanding of the way shadows work.

References

- NGSS. (2013). *Appendix G – crosscutting concepts*. Next generation science standards. Retrieved from <https://www.nextgenscience.org/sites/default/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf>.
- Next Generation Science Standards. *Topic arrangements of the next generation science standards*. NGSS. Retrieved from <https://www.nextgenscience.org/sites/default/files/AllTopic.pdf>
- Peep and the Big Wide World. (2011, April 28). *Peep and the big wide world: shadow play* [Video]. YouTube. <https://youtu.be/Ty0C8mH4Jy8>
- Sallas, Jennifer. *Why does my shadow change? Day 1*. Better lesson. Retrieved from <https://betterlesson.com/lesson/639840/why-does-my-shadow-change-day-1>

Observation Recording Sheet

Name: _____

Date: _____

Directions: Draw what you see when the Earth (beach ball) rotates different directions.

Distance of the rotation	Observation (drawing)
90 degrees from starting point	
180 degrees from starting point	
270 degrees from starting point	

Lesson Reflection Rubric

Teacher Name: _____

Date: _____

Student Name: _____

CATEGORY	4	3	2	1
Spelling, Punctuation, and Grammar	One or fewer errors in spelling, punctuation, and grammar in the report.	Two or three errors in spelling, punctuation, and grammar in the report.	Four errors in spelling, punctuation, and grammar in the report.	More than 4 errors in spelling, punctuation, and grammar in the report.
Components of the reflection	All required elements are present.	One required element is missing, but additional elements that add to the report have been added.	One required element is missing, and no additional elements have been added to the report.	The required element is missing.
Question/Purpose	The purpose of the reflection and the question to be answered is clearly identified and stated.	The purpose of the reflection and the question to be answered is stated in a somewhere unclear manner.	The purpose of the reflection and the question to be answered is partially identified and is stated in a somewhat unclear manner.	The purpose of the reflection and the question to be answered is unidentifiable and/or irrelevant.
Scientific Concepts/Vocabulary	Reflection illustrates accurate and thorough understanding of the scientific concepts and vocabulary.	Reflection illustrates an accurate understanding of most of the scientific concepts and vocabulary.	Reflection illustrates a limited understanding of the scientific concepts and vocabulary.	Reflection illustrates an inaccurate understanding of scientific concepts and vocabulary.
Evidence	Evidence is used accurately to explain and describe thoughts in a clear manner.	Evidence is used accurately to explain thoughts in a somewhat clear manner.	Evidence is used but does not make sense to explain thoughts.	Evidence is not used in the reflection.

Grade: _____ /20

Materials List

Inflatable beach balls (inflate prior to lesson)

Peep and the Big Wide World Video Clip (<https://youtu.be/Ty0C8mH4Jy8>)

Whiteboards and markers

2 unifix cubes per group

Paper circle

Notebook and pencil

Lamp, without the shade

Tape, one small piece per group

Observation data collection sheet

Sidewalk chalk

Lesson reflection rubric

Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013)

<p>Standard</p> <p>5-ESS1-2 Earth's Place in the Universe</p> <p>https://www.nextgenscience.org/dci-arrangement/5-ess1-earths-place-universe</p> <p>The chart below makes one set of connections between the instruction outlined in this article and the <i>NGSS</i>. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities.</p>	
Dimensions	Classroom Connections
Science and Engineering Practices	
<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> ▪ Represent data in graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships <p>Engaging in Argument from Evidence</p> <ul style="list-style-type: none"> ▪ Support an argument with evidence, data, or a model 	<ul style="list-style-type: none"> ▪ Students analyze shadow data to explain their observations and to analyze and explain their drawings of the shadows ▪ Students created a model of a person on the world and used a light source to represent the sun to show that as Earth rotates, their shadows change
<p>Disciplinary Core Ideas</p> <p>ESS1.A: The Universe and its Stars</p> <ul style="list-style-type: none"> ▪ The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth <p>ESS1.B: Earth and the Solar System</p> <ul style="list-style-type: none"> ▪ 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 	<ul style="list-style-type: none"> ▪ Students use a light source as their sun to analyze the affect that the sun's distance has on shadow size and shape ▪ Students consider the affect Earth's rotation has on the length and direction of shadows and analyze the changing positions at different times of the day
Crosscutting Concepts	
<p>Patterns</p> <ul style="list-style-type: none"> ▪ Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena 	<ul style="list-style-type: none"> ▪ Students observe and analyze the shadows changing length and direction to communicate the patterns that were noticed

<p>Stability and Change</p> <ul style="list-style-type: none"> ▪ Natural objects exist from the very small to the immensely large 	<ul style="list-style-type: none"> ▪ Students observe the Earth's rotation affecting the length and direction shadows to make connections between their size and the size of their shadows
<p><i>Building Towards</i> Performance Expectation (PE listing with Clarification Statement and Assessment Boundary)</p> <p>5-ESS1-2. 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 sky. <i>[Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.]</i> <i>[Assessment Boundary: Assessment does not include causes of seasons.]</i></p>	