Shifty Shadows (5th Grade)
Distance Learning Lesson

SYNOPSIS
Students will conduct experiments and collect data to support their claims that the rotation of the Earth and the apparent location of the Sun cause shadows to change over time.

STANDARDS SUPPORTED
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.

PHENOMENA
Shadows change direction and shape at different times of the day.

MATERIALS
- Notebook or paper
- Writing tool
- Coloring materials (for graph/chart)
- Chalk
- Small object (about 1-1.5 in. in height) like a Lego® figure, binder clip, battery, etc.
- Printable protractor
- Model Set Up
- Scissors
- Ruler
- Flashlight
- *Shadow Slideshow* (if needed)

ESSENTIAL QUESTIONS
- What is causing the shadows to change?
- How might different times of day affect an object's shadow?
- How does the Sun's apparent location affect the object's shadow?

LESSON

Facilitator (Teacher/Parent) Does	Student Does	Questions to Move Thinking Forward
Engage The teacher will show students this timelapse video of a chair's shadow. After viewing the video, prompt discussion amongst students by asking them some questions. • What do you notice? • What do you wonder? After receiving their responses to these questions, ask them to make claims about this phenomenon. • What is happening? • What is causing this to happen? Have the students revise their claims. • Are there any claims that don't fit? • Are there some claims that are better than others? *It is helpful if the teacher charts the students' ideas and questions. See the Shadow Slideshow for some examples of charting student claims.*	**Engage** Students will watch the video. After viewing this video, students will write in their notebooks what they notice and wonder about the video. Then they will discuss their answers in a group, and then with the teacher. As a group, students will try to make claims about what they saw in the video. Students will write their claims in their notebooks and revise them with their group. Once they have revised their claims, they will share a few with the class. *Do not erase the original claim. Students can use different colored pens to mark what was changed and what was kept.*	What do you notice? What do you wonder? What is happening? What is causing this to happen? Are there any claims that don't fit? Are there some claims that are better than others?
Explore 1 Take students outside to a place that can be easily marked with chalk. Group students together and give each group some chalk. Line students up in rows. *Works well if they are all facing the same direction*	**Explore 1** Taking turns, the pair of students will trace each other's shadows, making sure to mark the point and direction they were facing.	What does your shadow look like? What direction is your shadow facing? Where is the Sun?

LESSON (continued)

Facilitator (Teacher/Parent) Does	Student Does	Questions to Move Thinking Forward
Explore 1 (continued) Without directly looking up at the Sun, have your students make a note where the Sun is located in the sky. *The Sun can damage their eyes. This is just a general direction (i.e. behind them, in front of them, directly above them, etc.)* Repeat this a few times (3-5) throughout the day at regular time intervals (1hr, 2hr, etc.)	**Explore 1 (continued)** In their notebooks, students will draw what their shadow looks like. Students will also take note of the general direction of the Sun. Repeat this a few times (3-5) throughout the day at regular time intervals (1hr, 2hr, etc.)	What are some similarities and differences between the shadows we observed? Were there any patterns that you noticed?
Explain 1 Ask them to modify their claims about this phenomenon. What can you change about your claim given our new observations? Does the evidence support your claim? Is there any part of the claim you want to keep the same? Have the students revise their claims. Are there any claims that don't fit? Are there some claims that are better than others? *It is helpful if the teacher charts the students' ideas and questions.*	**Explain 1** Using the evidence gathered from the outside shadow observation, students will re-evaluate their claim. Students will again write their claims down and discuss them in their groups. Once they have revised their claims, they will share a few with the class. *Do not erase the original and revised claims. Students can use different colored pens to mark what was changed and what was kept.*	*See the questions in the first column* How did the shadows change? How might the Earth changing affect the way we see shadows?

LESSON (continued)

Facilitator (Teacher/Parent) Does	Student Does	Questions to Move Thinking Forward
Explain 1 (continued) What did you notice about the position of the Sun throughout the day? What is causing the Sun to move in the sky? Show the students this video: Apparent Movement of the Sun Explain to the students that as the Earth rotates around its axis, it moves like a spinning top. The Earth has an invisible line that runs down the center of the Earth called an axis. The Earth completes one rotation on its axis every day. This rotation is a circular path or 360 degrees. Because of this, the Sun seems to move across the sky throughout the day.	**Explain 1 (continued)** Students will watch the video and discuss why the Sun appears to be moving in the sky.	
Explore 2 After completing the outside exploration of shadows, the teacher will facilitate the creation of a model in the classroom. Remind the students about the shadow activity they conducted outdoors. Remind them of the apparent motion of the Sun. The teacher can ask a few of the following questions:	**Explore 2** *This can be done in groups or individually. Students will set up the model using the following directions. (See images in supplemental support for set up)	What do you think is causing the shadows to change? How does the Sun's apparent location affect the object's shadow? Prediction Questions: In what direction does the Sun appear to move in the sky? Remind the students: Is the Sun actually moving?

LESSON (continued)

Facilitator (Teacher/Parent) Does	Student Does	Questions to Move Thinking Forward
Explore 2 (continued) Ask the students to mark on their papers where the Sun would start its path. What direction will the Sun appear to move?* **If students struggle with this, try prompting them whether or not it rises/sets over the ocean. Is the ocean in the east or west?* *If the teacher chooses, they can connect this part to math concepts.* Why do we use a protractor? What shape is the Earth spinning in? How many hours are in a day? Divide 360 degrees by 24 hours to see how many degrees the Sun moves an hour. 15 degrees per hour. Before beginning the experiment, have students make guesses about the following questions: In what direction does the Sun appear to move in the sky? Remind the students: Is the Sun actually moving? At what time/angle do you think we will see the shortest shadow? Longest? What direction will the shadow face in relation to the Sun? Same direction? Opposite direction?	**Explore 2 (continued)** 1. Cut out the protractor along the outside solid line. 2. Cut a slit in the protractor base along the dotted line. 3. Fold the dotted line back to create a stand. 4. Place the protractor in the middle of a blank page in your notebook or a sheet of paper. Use tape to keep it upright if needed. 5. Draw a compass on the bottom of the page. 6. Place an object or figurine in the center of the page in front of the protractor. After the students have set up the paper, they will use a flashlight to explore how the Sun's location in the sky influences the length and direction of shadows. Students will respond and write their guesses in their notebooks. Students will move the flashlight over the paper in an arch along the outside of the protractor. This will mimic the apparent motion of the Sun. At every 15 degrees (one hour), students will use a ruler to measure the length of the shadow created by the flashlight.	At what time/angle do you think we will see the shortest shadow? Longest? What direction will the shadow face in relation to the Sun? Same direction? Opposite direction? After Experiment Questions: What are the lengths and directions of the shadows at each time? What do you think is causing the shadows to change? How does the Sun's apparent location affect the object's shadow?

LESSON (continued)

Facilitator (Teacher/Parent) Does	Student Does	Questions to Move Thinking Forward
Explain 2 Ask them to modify their claims about this phenomenon. What can you change about your claim given our new observations? Is there any part of the claim you want to keep the same? Have the students revise their claims and share them. Are there any claims that don't fit? Are there some claims that are better than others? Have students present their claims and explanations with the class.	**Explain 2** After collecting data about the length and direction of the shadows, students will discuss some ways to organize the data. (bar graph, line graph, etc.) In a group, students will decide which organizations work well and choose one to move forward with. After organizing their data into a chart or graph, students will revise their claim again and write a short explanation of what the graph is showing them. Making note of patterns that occurred. *Do not erase the original and revised claims from previous steps. Students can use different colored pens to mark what was changed and what was kept.* Students can present their explanation and graphs with the rest of the class.	What would be the best way to represent your data? What patterns can you see from the data you collected? Are these patterns predictable? What do you think is causing the patterns of the shadows to change? What evidence did you find that supports this? Do you think the patterns would change depending on the time of year?

MODIFICATIONS FOR DIFFERENT LEARNING

Synchronous	Asynchronous	Independent Learning
Engage Teacher shows students the timelapse video of the chair's shadow over a video conference. Students share what they notice and wonder with the class. Students work together with the teacher to create a claim about what is occuring. Teachers can compile student claims and place them into a chart for the students to look at and comment on. *Teachers can choose the best way to represent these student ideas, it can be done on the Shadow Slideshow.* Option 1: Students create a "small group" claim Option 2: Teacher creates a whole class list of claims Option 3: Teacher creates a whole class model with input from the students See link below for more information: Eliciting students' ideas | AST	**Engage** Teachers can pre-record the *Shadow Slideshow* (which includes the timelapse video) with voice commentary on the slides. Students can watch the *Shadow Slideshow* and respond with video via SeeSaw or other application.	**Engage** *If possible, students should discuss questions and reasoning with a family member or someone in the home about each section.* Students will watch the video independently and respond in the *Shadow Slideshow* what they notice/wonder about each picture. Students will write their claims in the *Shadow Slideshow* or on a document.

MODIFICATIONS FOR DIFFERENT LEARNING (continued)

Synchronous	Asynchronous	Independent Learning
Explore 1/Explain 1 Teacher introduces the observation and provides instructions for students over a video conference. Teachers can even provide an example set up for the students. Students will conduct the observation on their own. They can share their claims over a video conference. At this conference, students work with teachers and other students to revise claims. Teachers can compile student claims and place them into a chart for the students to look at and comment on. *Teacher can allow students to create individual claims, or create a singular "class claim" with input from students.*	**Explore 1/Explain 1** Teachers can pre-record the *Shadow Slideshow* with voice commentary on the slides to provide instruction. Students will conduct the observation on their own and write in their notebooks. Students can add their data and observations to a class document facilitated by the teacher. They respond and state their observations and claims via picture of their notebook, etc. Teachers can compile student claims and place them into a chart for the students to look at and comment on.	**Explore 1/Explain 1** Teachers can provide instructions on the *Shadow Slideshow* for students to conduct the observation. Students will conduct the outside shadow observation with the help of a family member, or someone living at home. Students will record in the *Shadow Slideshow* or on a document what they observed. They will also make revisions to their claim. Teachers can choose to add in an explanation of the Earth's rotation and how it affects how we see the Sun into the *Shadow Slideshow*.

MODIFICATIONS FOR DIFFERENT LEARNING (continued)

Synchronous	Asynchronous	Independent Learning
Explore 2/Explain 2 Teacher introduces the experiment and provides instructions for students over a video conference. Teachers can even provide an example set up for the students. Share predictions with the class. Students will conduct the experiment on their own. They can share their final claims over a video conference. *Teacher can allow students to create individual claims, or create a singular "class claim" with input from students* Students can present and explain their data over a video conference with the class.	**Explore 2/Explain 2** Teachers can pre-record the *Shadow Slideshow* with voice commentary on the slides to provide instruction. Students can write their predictions in their notebooks. Students will conduct the experiment on their own. They respond via video to state their final claim. Students can also upload a video of themselves presenting and explaining their data.	**Explore 2/Explain 2** Teachers can provide instructions on the *Shadow Slideshow* for students to conduct the experiment. Students can write their predictions in the *Shadow Slideshow* or document. Students will make final revisions to their claim. Students will record and chart or graph their data and place it in the slide show or turn in a document.

SUPPLEMENTAL SUPPORT

- Shadows Timelapse
- Shadows Slideshow - To edit this presentation, you can save a copy of document and then edit.
- Apparent Movement of the Sun
- Eliciting Students' Ideas | AST
- Printable Protractor
- Examples of How to Set Up the Model