Preparing for the Eclipse

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How to safely observe the Sun with young children

By Anna Hurst, Julia Plummer, Suzanne Gurton, and Dennis Schatz

On August 21, 2017, sky gazers all across North America will experience a total solar eclipse, arguably the most breathtaking of all astronomical phenomena. If you are in the 97 km wide path of totality, you will see the Moon slowly cover the Sun. When only a sliver of the Sun is visible, your surroundings will start to get dark, the temperature will drop, and birds will go to roost because they will think that night is coming. Finally, the Sun will be totally covered and the beautiful solar atmosphere (the *corona*) will become visible. Totality will only last about two minutes or fewer until the Sun becomes visible again. Although only some will see a total eclipse in August, everyone in the United States will see a partial eclipse and will need to be prepared to safely observe the event.

A Perfect Event for Early Learners

The August eclipse is an ideal astronomical event to observe with young children because it allows them to observe a powerful and easily accessible astronomical phenomenon. Observing scientific phenomena is children's first step toward engaging in scientific inquiry (Plummer and Ricketts 2016). Most astronomical phenomena are challenging to observe because they occur over long periods of time, we need telescopes to observe them, or they happen at night when young children are sleeping. A solar eclipse, however, occurs during the daytime and can be observed by using simple equipment, such as solar glasses or a pinhole projector (see the *Solar Science: All-American Total Solar Eclipse* insert in this issue for more safety information and directions).

A solar eclipse is also a relatively simple phenomenon—one that children can model using concepts with which they are already familiar. During an eclipse, the Moon blocks the Sun's light, producing a shadow that falls on the Earth. Shadows are a phenomenon that children encounter in their everyday lives. Thus, observing the phenomenon of the Sun going dark during the day can begin a conversation involving explanations that use models of the astronomical objects.

Eclipses can be powerful social events that may stimulate conversations about science for weeks and even years to come. A social experience such as this one has the potential to be a catalyst for further science exploration for a young child, and it may foster children's further interest in science.

A Pathway to the Skies

Over the last four years, educators and researchers working on the "My Sky Tonight: Early Childhood Pathways to Astronomy" project have researched methods that support young children's observations of astronomical phenomena (Plummer and Ricketts 2016). My Sky Tonight (MST) is a National Science Foundation–funded program from the Astronomical Society of the Pacific in partnership with three universities and four museums. The MST team has created a set of research-based, hands-on astronomy activities for three- to five-year-old children, which are distributed to children's museums and science centers across the United States and are available for free online (see Internet Resources). These activities are developmentally appropriate for children ages 3–5. Many of the activities focus on phenomena that children this age are able to experience directly, including phenomena related to the Sun, Moon, and Earth (three objects essential to understanding the solar eclipse).

Getting the Most out of the Eclipse

Investigating Shadows

To understand what causes a solar eclipse, one must first have a basic understanding of shadows. One of the MST activities, Bear's Shadow, focuses on the shadow phenomenon (see NSTA Connection for materials lists for these activities). Prior to formal instruction, young children often form many ideas about shadows, such as, "Everyone can see their shadow," "It follows you," and "The sunlight makes it happen because [the Sun is] so bright" (Worth and Grollman 2003, p. 131). Yet understanding how shadows form often requires the support of hands-on instruction that helps students connect the relative position of the light source, the object, and the shadow (Hadzigeorgiou 2015).

The activity begins with reading *Moonbear's Shadow* (Asch 2000), a story in which a bear tries to run away from his shadow. The book's illustrations show the positions of the Sun and the shadow changing throughout the day. The story prompts children to wonder, "How can a shadow appear long or short and face different directions?"

To investigate this question, children are invited to recreate scenes from the book by using a scientific model. In this case, we use a flashlight to represent the Sun and

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Students observe how Earth's rotation causes day and night.

Children model day and night with their whole bodies.

a figurine to represent the bear. We challenge children to make Bear's shadow long, short, in front of him, behind him, and so on, so they can use their own observations to make claims about how the Sun's location is related to shadow length and direction. We have found that young children often use more than verbal descriptions to make their claims: They often include gestures and manipulations of the model to communicate their ideas about light and shadows (Plummer and Ricketts 2016).

Encourage children to compare the flashlight's position and the shadow's length and direction. Giving children interesting prompts, questions, and tasks to try with the materials often leads to fun and unexpected responses. For example, when asked whether they could make Bear's shadow disappear (this happened at noon in the book), some children simply turned off the flashlight or put it under the table! This gave the teacher the opportunity to clarify the challenge; she referred to the book and the scene at noon. Children then attempted to use the models to make Bear's shadow disappear following the ideas from the book. These simple representations of the Sun and the bear engage children in scientific modeling as they test their ideas to understand and explain shadows.

Drawings can assess children's understanding of how shadows form. For young children, it is helpful to provide a sheet of paper with a picture or silhouette of a cartoon bear already photocopied onto the center of the page. Ask the child to draw Bear's shadow and where the Sun would have to be to make that shadow. A child beginning to understand how shadows form will be able to draw the Sun on the opposite side of the Bear's shadow. Through conversation, a child may reveal whether he or she understands the relationship between the height of the Sun in the drawing and the length of the shadow.

The story shows the Sun's changing position throughout the day and the resulting change in the position of Bear's shadow. As children investigate how shadows form, they start to understand the relationship between the Sun's position in the sky and length and direction of shadows. They will build on this understanding in future investigations, during which they track shadows throughout the day to learn about the Sun's apparent motion.

Understanding shadows is a first step toward understanding the phenomenon of a solar eclipse and prepares young learners to understand disciplinary core ideas (DCIs) in the *Next Generation Science Standards* (see p. 57). In the book, although not discussed, the fish in the pond experiences an eclipse when Bear's shadow falls on it and scares it away. In that case, the Sun is eclipsed by Bear, not the Moon. This is what everyone in the United States will experience on August 21, 2017, when the Moon eclipses the Sun.

For lesson plans and videos for Bear's Shadow and the other My Sky Tonight activities, as well as additional related resources, visit the My Sky Tonight website (see Internet Resources).

Modeling a Solar Eclipse

Talking to children about what they can expect to observe and experience during the eclipse can help them understand the objects that are involved in this phenomenon. Show children photographs of solar eclipses and ask whether they have any ideas about what causes eclipses. Some guiding questions for this discussion could include:

A child explores how changing the position of a light source changes the size and position of a shadow.

- What do you notice in the photograph?
- If the Sun is in the sky, does the eclipse of the Sun happen during the day or the night?
- What do you think causes a solar eclipse?
- What could cause something bright to become dark? Have you ever experienced anything like that?

Create a model using the children's own bodies to represent the Earth, a ball to represent the Moon, and a lamp to represent the Sun. Begin by kinesthetically modeling day and night on Earth. For example, tell students: "Let's all pretend that we are the Earth. Imagine that we live on the tip of our noses, Mt. Nose! Can you face the Sun (lamp) so that it's daytime on Mt. Nose? Now slowly rotate so that it is nighttime on Mt. Nose, facing away from the Sun." (Note: This activity is outlined in more detail in the Day and Night activity from My Sky Tonight [see Internet Resources].)

Next, model the solar eclipse. Have each child hold a large ball between his or her face and the lamp so that the ball blocks the light. Ask children, "Can you see the Sun now? This is what it will be like during the eclipse!" This activity is not intended for children to fully understand the details of a solar eclipse; rather, it provides them with initial exposure to the ideas. This will provide a foundation for additional learning through their real-world observations of the eclipse.

Observing the Solar Eclipse

The eclipse will be visible from every location in the United States, as long as the sky is clear of clouds. Most people will see a partial eclipse, with the Moon blocking most but not all of their view of the Sun. The total eclipse will be visible only along a narrow path extending from the northwest in Oregon to the southeast in South Carolina. It is safe to look directly at the Sun during the few minutes of total eclipse (when the Sun is completely covered), but any time that even a small piece of the bright Sun shows, it is essential to use eye protection. See the *Solar Science: All American Total Solar Eclipse* insert in this issue for more information about the eclipse at your location, including timing and the percentage of the Sun that will be covered, as well as information about safe viewing options.

Commercial Solar Viewing Glasses by Eclipse Safety for viewing Sun Spots and Solar Eclipses.

Safe Viewing Options

Be sure that you have a safe solar-viewing option when observing the eclipse. Safe-viewing strategies include observing through a telescope with a solar filter, using solar-viewing glasses, or making a projection of the partially eclipsed Sun with a telescope, binoculars, or a simple pinhole. Solar glasses should be modified with elastic or tape around the back so they stay on young children's small faces. For more information on these and other safe viewing options, see the insert in this issue of *Science and Children*, *Solar Science: All-American Total Solar Eclipse*; it can also be found online (see Internet Resources). Also see "Totality 2017: Eclipses and Eye Safety," page 58. Remind children and adults that they should never look directly at the Sun, except during totality. Ask other adults present during the eclipse to remind children of this as needed.

CAUTION

CAUTION

A child safely observes an image of the Sun using a sunspotter.

Before the Eclipse

Well in advance of the eclipse, make sure that your students have already safely observed the Sun using the same observing options you will be using during the event. There are two reasons for this. First, it is important for children to gain experience in using these observing aids safely when there is no rush to observe the eclipse. Second, this will provide children with experience observing the Sun when it is not eclipsed; making comparisons of observations is an important part of doing science. The partial eclipse will be visible over the course of hours as the Moon slowly covers the Sun, but the total eclipse only lasts two or three minutes! Therefore, viewing the Sun safely can start during the partial eclipse, which provides a useful comparison for later observations. Be sure you have enough adult supervision to ensure children follow safety procedures. We recommend one adult for every three to four children. Adults should ensure that children look directly at the Sun only through solar viewers or solar-viewing glasses.

During the Eclipse

As the Moon begins to cover the Sun and the eclipse event begins, you might encourage children to talk about what they are observing by asking questions:

- Do you notice anything different about the Sun yet?
- What is covering the Sun?
- Once totality begins—if you are lucky enough to be in the path of totality: Is the Sun completely dark? Is there any light at all around the Moon? (Don't forget that during totality, you have to directly observe the Sun.)

In addition to directly observing the eclipse, encourage children to notice what happens to the environment around them. You might ask questions such as: "Does it get any darker when the Sun is partially covered? How does it compare to what it is like outside at night?" If children are lucky enough to see the total eclipse, have them not only notice how dark the surroundings get, but what happens to wildlife (e.g., birds) and to the temperature: "Do you notice what the birds are doing? How does it feel now? Is it warmer or colder?"

After the Eclipse

Encourage children to draw what they observed and share their observations verbally with each other and the teacher. We have found that conversations around children's drawings are important opportunities to reveal their conceptual understanding when their ideas are not easily conveyed by their verbal abilities or the details of their drawings alone (Brooks 2009). Their drawings may not be accurate and they may vary greatly, sometimes showing just the Sun and other times showing the child observing the eclipse, or a drawing of the model you demonstrated earlier.

Assessment

Although it is not appropriate to assess student drawings for accuracy or specific details, the act of recording observations is a valuable scientific exercise that can be a first step toward more sophisticated scientific representations as students get older. We suggest that assessment instead focus on considering how children use elements of their drawings to support their explanation of the event. Look for evidence of children conveying details of the experience in their drawings that help them convey a sense of the phenomenon. Edson (2013) provides suggestions for assessment guidelines for children's science notebook entries, including observational drawings. This includes assessing for accurate colors, inclusion of key details, and (for older children) use of written notes such as scientific vocabulary. If observational drawings are a regular part of your classroom curriculum, look for ways your students' drawings of the eclipse show they are improving their skills in recording their observations.

Conclusion

Young children are natural explorers, learning about their world by experiencing it. Although most astronomical phenomena require special equipment to be observed, the solar eclipse and changing shadows from the Sun are phenomena that children can observe directly and explore through models. The total solar eclipse on August 21, 2017, is an opportunity not to be missed, whether you are in the path of totality or a location where you will see a partial eclipse. It is an astronomical phenomenon that children can observe, record, and model. This can inspire many science conversations and experiences in the following weeks and months. ■

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Brooks, M. 2009. Drawing, visualisation and young children's exploration of "big ideas." *International Journal of Science Education* 31 (3): 319–41.

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Hadzigeorgiou, Y. 2015. Young children's ideas about physical science concepts. In *Research in early childhood science education*, ed. K.C. Trundle and M. Sackes. New York: Springer.

NGSS Lead States. 2013. *Next generation science standards: For states, by states.* Washington, DC: National Academies Press. *www.nextgenscience.org.*

Plummer, J.D., and A. Ricketts. 2016. *Engaging preschool-age children in multimodal evidence-based explanations for astronomy phenomena during museum programs.* Paper presented at the National Association for Research on Science Teaching conference, Baltimore, MD.

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Internet Resources

My Sky Tonight
www.astrosociety.org/MySkyTonight

Excerpt from Solar Science
www.nsta.org/publications/press/extras/files/solarscience/SolarScienceInsert.pdf

Solar Science: Exploring Sunspots, Seasons, Eclipses, and More by Dennis Schatz and Andrew Fraknoi, NSTA Press, 2016.
www.nsta.org/store/product_detail.aspx?id=10.2505/9781941316078

NSTA Connection

Download the materials lists for Bear's Shadow, the modeling activity, and eclipse observation at *www.nsta.org/SC1703*. View videos of these activities in our digital issue (see *www.nsta.org/publications/digitaljournals.aspx*.)

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

1-ESS1 Earth's Place in the Universe

www.nextgenscience.org/dci-arrangement/1-ess1-earths-place-universe

The chart below makes one set of connections between the instruction outlined in this article and the *NGSS*. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities. The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectation listed below.

Performance Expectation	**Connections to Classroom Activity** *Students:*
1-ESS1-1. Use observations of the Sun, Moon, and stars to describe patterns that can be predicted.	• use models to make sense of how the changing positions of shadows are the result of the Sun's changing position throughout the day.
Science and Engineering Practices	
Developing and Using Models	• use a model to test the relationship between the position of a light source and the length/direction of a shadow.
Engaging in Argumentation From Evidence	• make claims based on evidence using a model of the Sun's position throughout the day.
Disciplinary Core Idea	
ESS1.A: The Universe and Its Stars • Patterns of the motion of the Sun, Moon, and stars in the sky can be observed, described, and predicted.	• construct explanations for how the Sun's position in the sky is related to the position of shadows throughout the day.
Crosscutting Concept	
Patterns	• consider the Sun's apparent motion as a pattern of change throughout the day.