Total Solar Eclipse: A Shadowy Experience?

7th Grade Earth Science

August 2016

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This unit was submitted to the Pre-Service Educator Eclipse Competition
Sponsored by the Montana Space Grant Consortium

Total Solar Eclipse: A Shadowy Experience Unit

Topic Explanation: Since the beginning, solar eclipses have fascinated people for many decades. In ancient times, stories were used to explain this phenomenon with each culture having its own legend to explain their cultural perspective. As technology evolved, scientists began to better understand the relationship between the sun, moon and earth from a scientific perspective. Explanations based on scientific evidence explain the solar eclipse phenomena from a scientific perspective. In this unit both the cultural legends and scientific evidence are used to explain the solar eclipse phenomena.

Unit Overview

Students first explore the solar eclipse phenomena from a cultural perspective. In groups, student's research legends related to the solar eclipse of ancient cultures and share what they learned with the class by acting them out. A class chart is created to compare the legends from different cultures.

Next, students move into understanding the solar eclipse from a scientific perspective. Students create a model of the solar eclipse to explore the unique relationship between the sun, the earth, and the moon that results in solar eclipses, with a focus on proportions and distances between the sun, moon, and earth. Integrating mathematics, students engage in an arithmetic exercise using shadows, measurements, and similar triangles to determine how the sun creates shadows on earth.

This unit not only aligns with the Next Generation Science Standards, but also the South Dakota Oceti Sakowin Essential Understanding Standards. These are newly introduced education standards approved by South Dakota Department of Education to boost knowledge about the Oceti Sakowin through education. To align with this standard, students are introduced to the Lakota Winter Counts with a brief explanation of the use of Winter Counts for the Lakota and how the pictographs on them were deciphered. They will analyze the Winter Counts and determine the year(s) in which the solar eclipse appeared across North America, and then research other historical discoveries or record of those occurrences. This will explain how humans interpreted solar eclipses before astronomers and technology investigated exactly what was happening and why. This lesson was developed in collaboration with Dr. Craig Howe, Director of the Center for American Indian Research and Native American Studies; the Lakota cultural perspective throughout this unit was added through this collaboration. In the end students create a news broadcast to tell the public about the upcoming solar eclipse occurring on August 21, 2017.

NOTE: For this unit, students need to have a background of geometry and understand in order for shapes to be similar their dimensions have to be proportional. Also, students will need to understand how scale and scale factor are involved in keeping shapes similar in their dimensions. May want to add they have understanding of the moon orbiting around the earth, the earth orbiting around sun, and that both the moon and earth rotate on an axis.

Standards:

Next Generation Science Standards Science Standards for Middle School earth Science:

MS-ESS1-1: 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.

MS-ESS1-3: Analyze and interpret data to determine scale properties of objects in the solar system.

Oceti Sakowin Essential Understanding Standards

Oceti Sakowin Essential Understanding Standard 6: (Analyzing) Grades 6-8: Students are able to compare events recorded on Winter Counts to dates in American History.

Common Core State Standards

Math:

CCSS.Math.Content.7.RP.2: Recognize and represent proportional relationships between quantities.

CCSS.Math.Content.7.G.1: Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

Language Arts:

CCSS. ELA- Literacy.W.7.3 Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.

NASA's Strategic Plan Objectives (2014)

1.4: Understand the sun and its interactions with earth and the Solar System, including space weather

2.4: Advance the Nation's STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teacher, and faculty in NASA's missions and unique assets.

Essential Understanding: The sun, earth and moon is a natural system whose relationship has regular patterns of phenomena that inspire cultural beliefs and can be understood through observation and measurement.

Essential Questions

Post on a wall in the classroom for students to reference each day.

1. How has the progression of human interpretation of solar eclipses changed over time?
2. Are solar eclipses a shadowy experience?

Goals and Objectives

Goal One: Students will understand how science uses evidence to explain the occurrence of a solar eclipse.

Objective One: Students will analyze ancient civilization legends to identify the (ancient) cultural perspectives about solar eclipses.

Objective Two: Students will use scientific evidence to provide a rational explanation for the occurrences of solar eclipses.

Goal Two: Students will understand why solar eclipses only occur under certain circumstances (specifically within the relationship between the sun, the earth, and the moon) and that only certain areas that lie within the predicted path of totality actually experience a total solar eclipse.

Objective One: Students will demonstrate and explain the unique alignment that needs to be in place for the earth, sun, and moon to create a shadow on earth.

Objective Two: Students will illustrate and explain why a solar eclipse shadow only covers a part of the earth.

Objective Three: Students will explain the difference between a partial and total solar eclipse.

STEM Behavior/Skills:

__X__Collaboration	____Asking Questions
__X__Devoloping and Using Models	____Defining Problems
_____Planning Investigation	_X__Carrying Out Investigation
_____Analyzing and Interpreting Data	_X__Using Math and Computational Thinking
__X__Constructing Explanations	_____Designing Solutions
__X__Engaging in Argument from Evidence	_____Obtaining and Evaluating Information
_____Other (specify):	_X__Communicating Information

Materials:

Access to the internet (computers, laptops, iPads, tablets, etc.) at least 1 for each group of 3-4 students

1 – 1 ½ inch Styrofoam ball for each group of students

1 – 6 inch Styrofoam ball or similar for each group of students

1 – 3 inch Styrofoam ball or regular ball for each group of students

1 – Lamp base and 1 LED bulb - for the whole group to set in the middle of the classroom **OR** 1 flashlight for each group of students

1 – Flexible tape measure for each group of students

1 – Solar Eclipse Glasses for each student

1 – Notebook/Interactive Journal per student to record their findings throughout the unit

Anchor Charts for posting ideas on walls. – Students can place a sticky note on the chart if they have questions throughout the unit and other students can help answer them.

Teacher provides masking tape or painters tape.

Note: If students do not have a journal, have them create one with the theme of space or solar eclipses

Hanwi and Wi story image (can be found under “Engage” Lesson 1)

Handout for different cultural perspectives: Attached at the end of the unit

Power Point of images of Solar Eclipses: The following are a list of websites that can be used to create a Power Point

- https://www.indiegogo.com/projects/bloon-360view-of-a-total-solar-eclipse-from-space#/
- http://petapixel.com/2013/08/29/eclips-photos-captured-from-space/
- https://en.wikipedia.org/wiki/Solar_eclipse
- http://www.aluxurytravelblog.com/2015/03/20/the-solar-eclipse-over-europe-and-where-to-see-the-next-total-solar-eclipse/
- http://www.businessinsider.com/how-to-see-solar-eclipse-2015-from-us-2016-3
- http://www.allabout-energy.com/wealth_joy_abundance_now/energy/
- http://apod.nasa.gov/apod/ap990830.html
- https://svs.gsfc.nasa.gov/4390

http://www.eclipse2017.org/2017/books.htm - This is an excellent resource for more information about the 2017 Total Solar Eclipse and other possible extension activities.

Solar Eclipse Unit: A Shadowy Experience? Lesson One

Grade/ Grade Band: 7th Grade	**Topic:** Legends about Solar Eclipses	**Lesson #** __1_ **in a series of** __4__ **lessons**

Brief Lesson Description: Students explore legends from different cultures and time periods to understand how human interpretations of solar eclipses have changed. Students will have a chance to ask their own questions about solar eclipses and what they want to learn about them.

Performance Expectation(s):

CCSS. ELA- Literacy.W.7.3 Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.

Specific Learning Outcomes:

Goal One: Students will understand how science uses evidence to explain the occurrence of a solar eclipse.
Objective One: Students will dramatize their comprehension of ancient civilization legends and identification of their cultural perspectives about solar eclipses. (This measurable goal will involve a skit with a rubric assessment included in the "Explore" section of the lesson. Students will also create an Ancient Civilization Legends Chart.)

Narrative / Background Information

Prior Student Knowledge:

Students will need to know that a solar eclipse happens when the moon hides the sun so that they can understand what these cultures were seeing when they wondered what this phenomena was. It is important to explain to students that these cultures were using the best knowledge and technology they had at the time to explain the phenomena occurring in the sky.

A fun and edible tool to use to teach the Moon phases to students is the Oreo Moon Phases activity. http://spaceplace.nasa.gov/oreo-moon/en/

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
NA due to performance expectation is a literacy standard	NA	NA

Possible Preconceptions/Misconceptions:

Make sure to avoid using the word "myth" as each culture used their best knowledge of what was going on to explain the phenomena

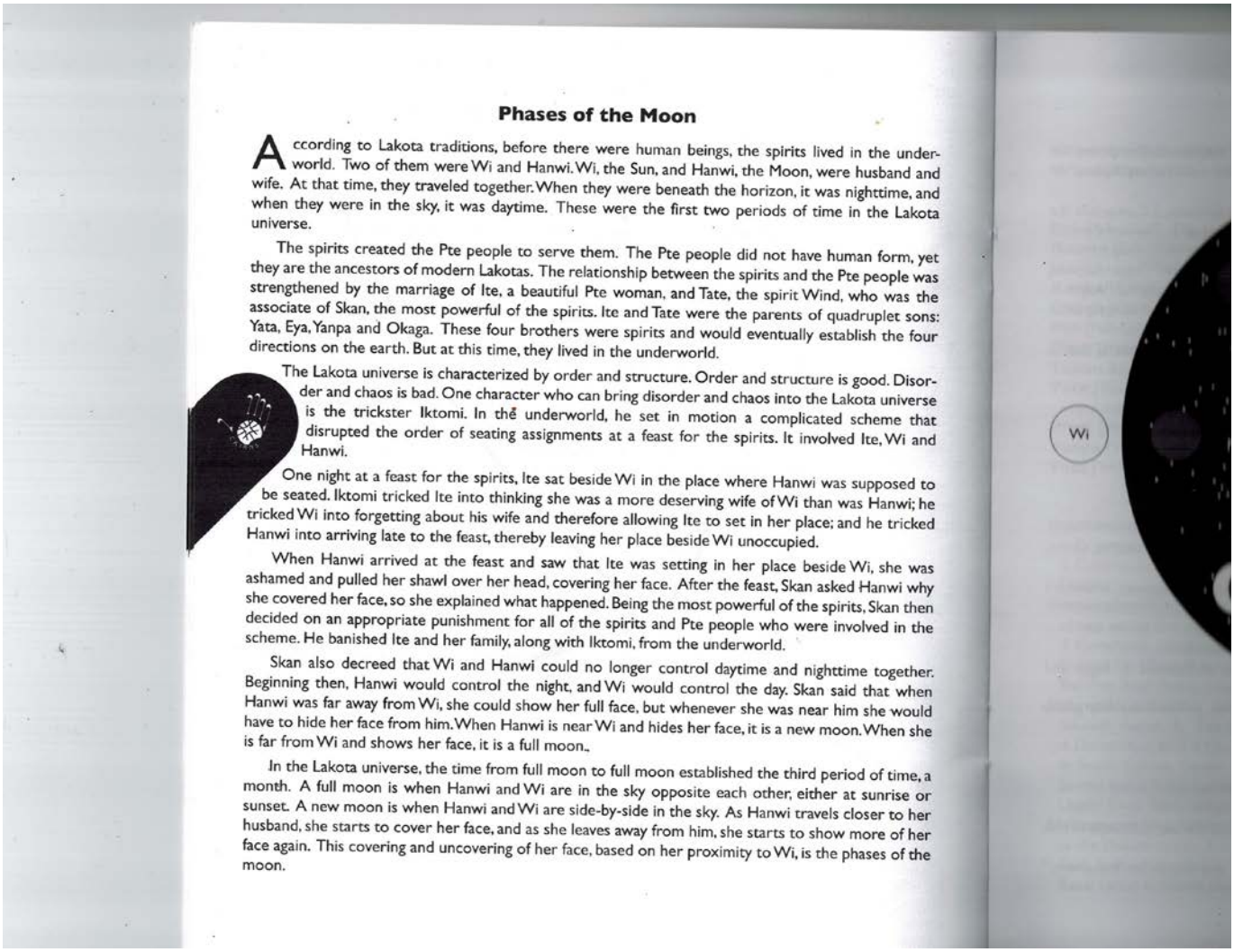
LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Read the Lakota legend about the sun (Wi) and the moon (Hanwi) from *Tender Reverence* by Center for American Indian Research and Native Studies, to help students identify the different phases of the moon, focusing on the new moon phase. Have students close their eyes as you read the story, allowing students to visualize the story in their head. Students should pay close attention to the details of the story in order to form a picture in their mind of what is going on in the story. Have students share what they visualized in their head. Notice how students will have different ideas and perceptions of what happened in the story. Follow with a discussion about ancient views on the relationship between the sun, the moon and the earth. Then tell students over the next several days they will explore that relationship, specifically focusing on solar eclipses. Ask students what they know about solar eclipses. Students will write their ideas down in their journal. Have

students share their ideas; write students' ideas down on a chart in the front of the classroom so that all students are able to see and hear each other's ideas, as well as refer back to during the course of the unit. (At this time students' knowledge of solar eclipses will become evident. Teachers address misconceptions during the unit.) http://www.nativecairns.org/CAIRNS/Emergence_Sun_and_Moon.html

Another Lakota story that can be used is *Thirteen Moons on Turtle's Back* http://oyate.org/index.php/component/hikashop/product/682-thirteen-moons-on-turtle-s-back?Itemid=114



Phases of the Moon

According to Lakota traditions, before there were human beings, the spirits lived in the underworld. Two of them were Wi and Hanwi. Wi, the Sun, and Hanwi, the Moon, were husband and wife. At that time, they traveled together. When they were beneath the horizon, it was nighttime, and when they were in the sky, it was daytime. These were the first two periods of time in the Lakota universe.

The spirits created the Pte people to serve them. The Pte people did not have human form, yet they are the ancestors of modern Lakotas. The relationship between the spirits and the Pte people was strengthened by the marriage of Ite, a beautiful Pte woman, and Tate, the spirit Wind, who was the associate of Skan, the most powerful of the spirits. Ite and Tate were the parents of quadruplet sons: Yata, Eya, Yanpa and Okaga. These four brothers were spirits and would eventually establish the four directions on the earth. But at this time, they lived in the underworld.

The Lakota universe is characterized by order and structure. Order and structure is good. Disorder and chaos is bad. One character who can bring disorder and chaos into the Lakota universe is the trickster Iktomi. In the underworld, he set in motion a complicated scheme that disrupted the order of seating assignments at a feast for the spirits. It involved Ite, Wi and Hanwi.

One night at a feast for the spirits, Ite sat beside Wi in the place where Hanwi was supposed to be seated. Iktomi tricked Ite into thinking she was a more deserving wife of Wi than was Hanwi; he tricked Wi into forgetting about his wife and therefore allowing Ite to set in her place; and he tricked Hanwi into arriving late to the feast, thereby leaving her place beside Wi unoccupied.

When Hanwi arrived at the feast and saw that Ite was setting in her place beside Wi, she was ashamed and pulled her shawl over her head, covering her face. After the feast, Skan asked Hanwi why she covered her face, so she explained what happened. Being the most powerful of the spirits, Skan then decided on an appropriate punishment for all of the spirits and Pte people who were involved in the scheme. He banished Ite and her family, along with Iktomi, from the underworld.

Skan also decreed that Wi and Hanwi could no longer control daytime and nighttime together. Beginning then, Hanwi would control the night, and Wi would control the day. Skan said that when Hanwi was far away from Wi, she could show her full face, but whenever she was near him she would have to hide her face from him. When Hanwi is near Wi and hides her face, it is a new moon. When she is far from Wi and shows her face, it is a full moon.

In the Lakota universe, the time from full moon to full moon established the third period of time, a month. A full moon is when Hanwi and Wi are in the sky opposite each other, either at sunrise or sunset. A new moon is when Hanwi and Wi are side-by-side in the sky. As Hanwi travels closer to her husband, she starts to cover her face, and as she leaves away from him, she starts to show more of her face again. This covering and uncovering of her face, based on her proximity to Wi, is the phases of the moon.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Note: Need access to internet for this activity so students can construct in depth research on each legend or misconception.

Divide students into groups. Each group is assigned a belief from ancient civilizations as well as scientific views from both past and present on solar eclipses. Students conduct research to learn basic information as well as an overview of the selected ancient civilizations' belief on solar eclipses. To expose the entire group to each legend, each group will prepare a short skit about their assigned ancient belief to perform in front of the class. All will have about 45 - 90 seconds to perform. (See attachment for different types of legends and misconceptions.)

Rubric for Skits:

5-4 points	3-2 points	1-0 points	Total Points Earned
Identifies the culture and accurately presents the culture's perspective of the solar eclipse.	Somewhat identifies the culture and somewhat accurately presents the culture's perspective of the solar eclipse.	Does not identify the culture and inaccurately presents the culture's perspective of the solar eclipse.	
All students had an equal role in developing and presenting the skit.	Only half of the students were involved in developing and presenting the skit.	Less than half of the students were involved in developing and presenting the skit.	
Skit was organized and creative. .	Skit was somewhat organized and creative.	Skit was not organized.	
Total			/15

EXPLAIN: Concepts Explained and Vocabulary Defined:

After students present their skit, have a discussion with the students. Students explain what their assigned ancient culture observed and the culture's explanation for solar eclipse phenomena. Why it happened? What was their inference based on? How do you know?

ELABORATE: Applications and Extensions:

Have students list the civilizations and a 1-2 sentence about its beliefs on solar eclipses. Have students create the chart below in their journals. Then, have students fill in the first two columns of the chart at this point in the unit, and explain that the last one will be addressed later. Allow time for students to share what they wrote with the rest of the class if they are comfortable.

This chart will allow students to tap into their prior knowledge about solar eclipses and understand what they know on this topic. Using the same chart, create a classroom chart. Either fill in the chart as students present their findings or have students write/post their findings.

Ancient Civilization Legends Chart

Civilization	Belief based on observation	How is this belief based or not based on scientific evidence?

EVALUATE:

Have students write in their journals what they learned about eclipses and what they want to know. Students share their ideas and discoveries from the lesson. Encourage students to challenge and expand each other's ideas.

Exit slips: Student share something that they learned from the lesson and something they would like to learn.

Elaborate Further / Reflect: Enrichment:

Solar Eclipse Unit: A Shadowy Experience? Lesson Two

Grade/ Grade Band: 7th Grade	**Topic:** Solar Eclipse Classroom Model	**Lesson # __2__ in a series of __4__ lessons**

Brief Lesson Description: In this lesson students create a model of a solar eclipse using a light source, Styrofoam balls. Using the model, students will explore and come to an understanding of how objects create different shadows and discuss this with each other.

Performance Expectation(s):

MS-ESS1-1: 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.

CCSS.Math.Content.7.RP.2: Recognize and represent proportional relationships between quantities.

Specific Learning Outcomes:

Goal Two: Students will understand why solar eclipses only occur under certain circumstances (specifically within the relationship between the sun, the earth, and the moon) and that only certain areas that lie within the predicted path of totality actually experience a total solar eclipse.

Objective One: Students will demonstrate and explain the unique alignment that needs to be in place for the earth, sun, and moon to create a shadow on earth. (This measurable goal will involve journal entries that have accurate illustrations of their solar eclipse model activity with their generalization of why this phenomena occurs. Note: There is no plausible way for it to be drawn to scale, as it would be too large. However, the general idea of the unique alignment and sizes should be illustrated.)

Narrative / Background Information

Prior Student Knowledge:

Students will need to understand that the earth is rotating on an axis and orbiting around the sun as well as the moon is orbiting around the earth.

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena.	ESS1.A: The Universe and Its Stars ● Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. ● ESS1.B: earth and the Solar System ● This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of earth across the year.	Patterns ● Patterns can be used to identify cause-and-effect re*lationships.* *Connections to Nature of Science* Scientific Knowledge Assumes an Order and Consistency in Natural Systems ● Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

Possible Preconceptions/Misconceptions:
Students may not understand that the sun is the largest object within the sun, earth, and moon relationship; the smallest object, the moon, is in between the earth and the sun and creates a shadow on earth.

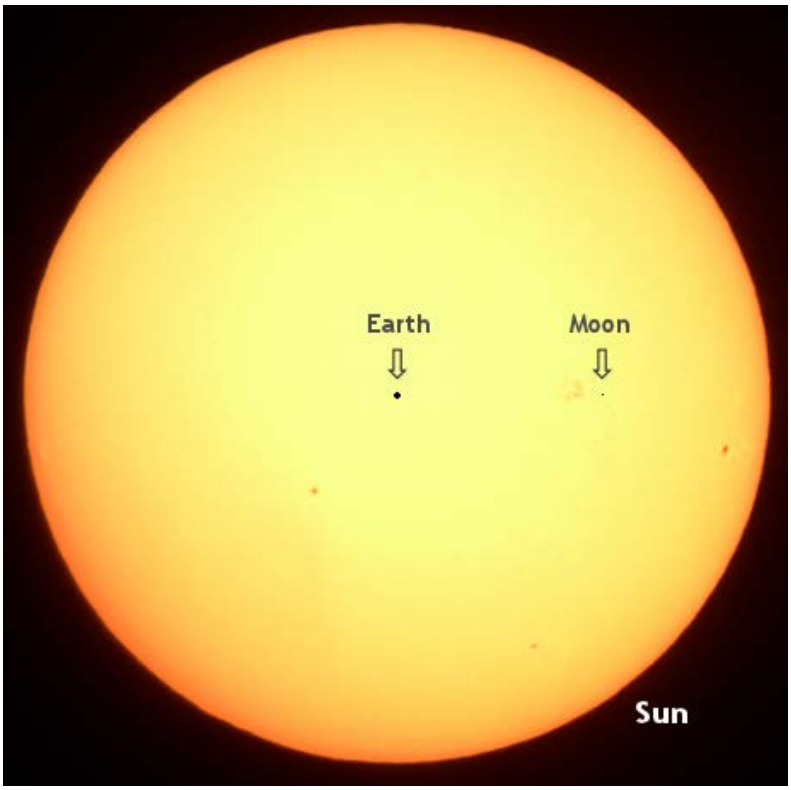
Option: NASA's Solar Dynamic Website: https://www.nasa.gov/mission_pages/sdo/the-sun-now/index.html - this site allows students to view live images of the sun.

Suggestion: Display a visual for students to see with a scale model of distances and sizes of the sun, earth, and moon.

- The sun is approximately 400 times bigger in diameter than the moon and the sun is approximately 400 times further away from the earth than the moon. Also, the moon is one-sixth the size of earth.

These are approximations:

- sun: 864,576 mi or 1,392,000 km in diameter
- Distance from sun to moon: 91,341,565 miles or about 150,000,000 km
- moon: 2,159 mi or 3,475 km in diameter
- Distance from moon to earth: 238,855 miles or 384,400 km
- earth: 7,918 mi in diameter



NASA's Solar Dynamic Website: https://www.nasa.gov/mission_pages/sdo/the-sun-now/index.html

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Students discuss their thoughts on the performances of the previous lesson, emphasizing what they learned about ancient civilizations' beliefs on solar eclipses. Show the Power Point displaying different images of solar eclipses, both total and partial; some images come from different angles (ground level, bird's-eye view, above the atmosphere, aboard the ISS). Ask the students to look for a common thread throughout the images. When finished with the slideshow, ask the students if they noticed a common thread and if so, what was it? Have students write a sentence or two in their journals about what they already know about solar eclipses and also asking questions about what happens during an eclipse, or what the shadow looks like. (Materials list contains links to websites that contain powerful images of the Solar Eclipse in order to create a Power Point).

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

This lesson was adapted from:
http://www.carolinacurriculum.com/premium_content/eBooks/Earth+Space/pdfs/Lesson_6.pdf

Room Set-up: Set a lamp in the middle of the room. Clear enough space for students to stand around the lamp. Prepare the room to be darkened during the activity.

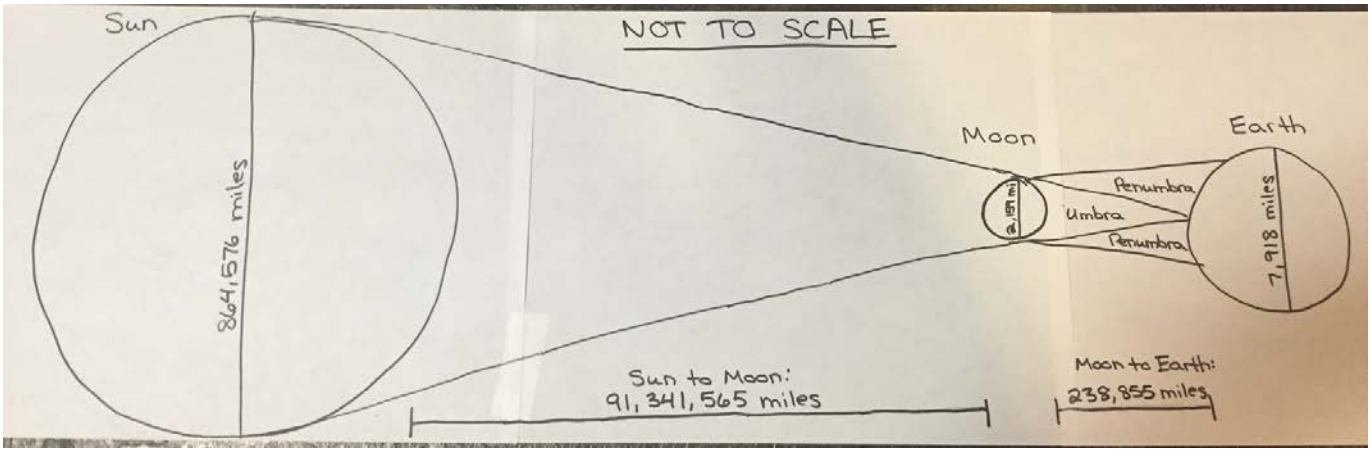
Part One:

1. Break students into groups of 3-5. Have each group take a place around the lamp, which represents the sun.
2. Turn off or dim the lights to help enhance the vividness of the shadows.
3. Have one student from each group hold the moon model (1 ½ " Styrofoam ball on a stick) in front of them with arm extended. Using their head as representing the earth, have students model a new moon phase (the side of the moon facing the student is not lit up). NOTE: The alignment to demonstrate a new moon is sun (lamp), moon (Styrofoam ball on a stick), earth (student).
4. Have students explore how to completely block the sun's light by changing the distance between the moon model and the earth (student's head). Have students discuss if distance between the moon and earth has an impact on eclipsing (blocking) the sun. Have group members record/diagram their observations of eclipsing the sun and the shadows. To help students start thinking critically, ask "How can the small moon block the massive sun's light completely?"
5. Have students change the position of the moon slightly above and below the totally blocked light. Have students discuss, write/diagram their observations. Ask students: Does the light remain totally blocked? Why or why not?

Part Two:

6. Have students work in their group to create a solar eclipse by using a 6" Styrofoam ball to represent earth and a 11/2" Styrofoam ball on a stick to represent the moon.
7. Using the Styrofoam balls, have students explore the positions of the sun, moon, and earth to completely block the sun's light. Have students measure the distance between the sun and moon, moon and earth. Have them record their measurements and write/diagram their observations in their journal.
8. Turn off or dim the lights to help enhance the vividness of the shadow during activity.
9. Students should represent the rotation of the earth (counter-clockwise) as well as the orbit of the moon around the earth (counter-clockwise) in order to understand the movement of the shadow.

Optional Extended Activity: Students can explore using different objects to represent the moon or earth and see the different shadows it creates. For example, during the second attempt to achieve an eclipse,



students will use a larger ball to represent the moon. In the third attempt to create the shadow on the Styrofoam ball, students will use a smaller ball to represent the moon. Students will be able to see how the size and distance between the earth and the moon, in relation to the sun play a key role in an eclipse happening.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Students share/explain what they discovered in their model. Encourage students to challenge each other's ideas and explanations according to what they found.

Key points for discussion:

- The position of the moon relative to earth and the sun.
- The distance of moon relative to earth, and distance of sun relative to earth and moon.
- Introduce the terms solar eclipse, total solar eclipse and partial solar eclipse. A total solar eclipse blocks out all light from the sun and a partial solar eclipse only blocks out some light.
- Be sure students add the labels to their diagrams.
- Only those that are in the shadow of the moon will be able to witness the eclipse.
- Discuss the measurements.

Sample questions to encourage discussion:
What did you discover about the size of the objects and the shadow created?
How does the distance impact the creation of a shadow?
How does position of each of the objects impact the creation/location of the shadow?

Vocabulary: Solar Eclipse, total solar eclipse, partial solar eclipse

ELABORATE: Applications and Extensions:

Create a classroom model with cut outs of poster board models of the earth, sun, and moon and tape them to the wall. Record the approximate diameters of each and the distances from each other on the wall model using masking tape. (Note to student these will not be drawn to scale as it is too enormous to contain in a classroom.)

EVALUATE:
Students draw a model of their activity in their journals, with a paragraph explaining their thoughts- emphasizing the importance of the size/distance unique relationship between earth, sun, and moon system. Students will also need to include what they discovered in the second investigation and how distance and size effects the solar eclipse.

What did you discover about the size of the objects and the shadow created?
How does the distance impact the creation of a shadow?
How does position of each of the objects impact the creation/location of the shadow?

Elaborate Further / Reflect: Enrichment:

Solar Eclipse Unit: A Shadowy Experience? Lesson Three

Grade/ Grade Band: 7th Grade	**Topic:** Solar Eclipse Classroom Model	**Lesson #** __3__ **in a series of** __4__ **lessons**

Brief Lesson Description: In this lesson students will use mathematics to understand the reason for the shadow created on earth using the model created on the classroom wall in the previous lesson. Students will explore a couple of resources to help better understand what is happening during this phenomenon.

Performance Expectation(s):
MS-ESS1-1: 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.

MS-ESS1-3: Analyze and interpret data to determine scale properties of objects in the solar system.

CCSS.Math.Content.7.G.1: Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

Specific Learning Outcomes:
Goal Two: Students will understand why solar eclipses only occur under certain circumstances (specifically within the relationship between the sun, the earth, and the moon) and that only certain areas that lie within the predicted path of totality actually experience a total solar eclipse.
Objective Two: Students will illustrate and explain why a solar eclipse shadow only covers a part of the earth.
Objective Three: Students will explain the difference between a partial and total solar eclipse. (For objectives two and three, these measureable goals will involve students replicating the sun, moon, earth model found on the classroom wall, along with their ideas elaborating about the various aspects of Solar Eclipses. For example, if students are explaining Path of Totality in their journals, they demonstrate they have a deep understanding of the content.)

Narrative / Background Information

Prior Student Knowledge: Key terminology such as, total eclipse, partial eclipse, umbra and penumbra are essential to understanding the "Path of Totality" that occurs during a total solar eclipse

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and	ESS1.B: earth and the Solar System ● The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.	Scale, Proportion, and Quantity ● Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. *Connections to Engineering, Technology, and Applications of Science* Interdependence of Science,

differences in findings.		Engineering, and Technology ● Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.

Possible Preconceptions/Misconceptions:
Students could possibly mistake that the earth orbits around the sun, but it also rotating on its axis. The moon also orbits around the earth as the earth is orbiting around the sun.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
Note: It is important that students have solar eclipse glasses or some sort of eye protection against the sun in this activity. Emphasize to students that it is important to NEVER look directly at the sun. If a sunny day is not optional, consider using a lamp in front of the class for all students to see. The activity should work the same, as the lamp will pose as the sun.

Take the students outside to simulate a total solar eclipse. Wearing Solar Eclipse Glasses and facing the sun, students extend one arm and cover the sun with their thumb. This is an example of a total solar eclipse as the thumb (representing the moon) covers up the sun and leaves a shadow on the student (representing the earth.) Next, have students explore making partial solar eclipses with their thumb by moving their thumb to only cover part of the sun. Next, pair up students. Have student A stand with his/her back to the sun and looking at student B. Have student B cover the sun with their thumb. Student A looks for the shadow on student B. Do the same in creating partial solar eclipses. Have a discussion where students refer to what they learned from the previous lesson and how it relates to this model. Then, have students switch roles, and continue discussion. Students draw and write what they observe in their journals.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Return back to the classroom. Have students return to their groups from the previous lesson. Discuss with students the distances and sizes of the sun, earth, and moon. Have students look at their diagrams in their journals from the previous lesson and what they entered outside.

First, have students look at their diagrams and discuss what they notice, using the questions below as a guide. (Could post the questions on the board to spark discussion). Have a class discussion where the teacher uses the classroom model on the wall and the students refer to their diagrams from the previous lesson. Use the questions below to guide the discussion.

What geometric shapes do you see other than a circle? (Triangles).
Where are the triangles located? Have students draw them on their diagram.
Do you see a small triangle and a large triangle?
What is the relationship between these two triangles?
What do you notice about the corresponding sides?
Do you notice more than one shadow that is being created on earth? (Students should notice the Umbra and Penumbra; explain that they will discuss this in the next section of the lesson).

This discussion will help students visualize the perfect proportional relationship between these three celestial beings, by exploring the ratios between the distances, and how the shadow can only be seen from certain points of viewing, which in this case is a path. Referring back to the thumb activity, students will be able to discuss their discoveries about total and partial eclipses. Further explain how the path followed by the shadow of the moon, during an eclipse, is called the Path of Totality.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Discuss what students analyzed in their measurements from lesson two's activity. Post the following on the wall: The sun is approximately 400 times bigger in diameter than the moon and the sun is approximately 400 times further away from the earth than the moon. Also, the moon is one-sixth the size of earth. Tell the students this is significant in why the earth experiences solar eclipses and other planets do not. This will be further explained in the eClips they are about to watch.

Then, watch NASA eclips
http://nasaeclips.arc.nasa.gov/search/?terms=eclipse&v=launchpad-solar-eclipses

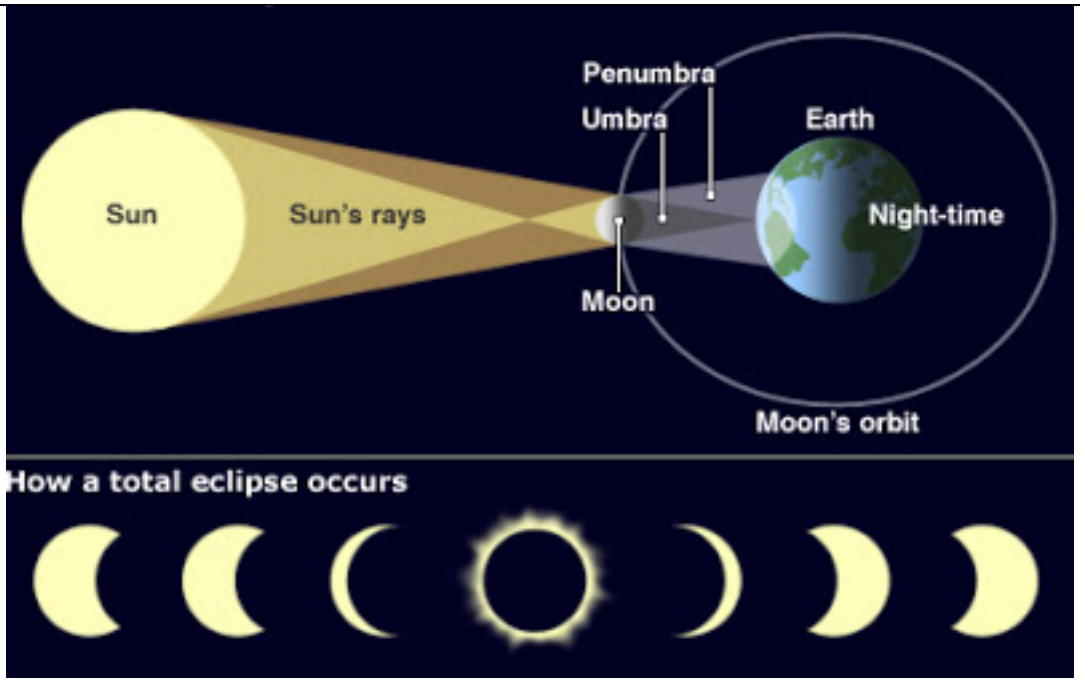
Stop the Eclip at each point that you would like to emphasize and refer back to the classroom model to help explain.

Suggestions:
Stop the video at 1:35: Ask students to recall from the previous lesson with the sun, earth, and moon model, and the outdoor activity, what happens when the moon passes between the earth and the sun? What does the moon look like from earth?

Stop the video at 5:35: Refer to the classroom model on the wall. Have students explain how to create the two similar triangles from the sun to earth, and moon to earth. Discuss how the diameters of the sun and the moon are proportional and the distance from the sun to the moon is proportional to the distance from the sun to earth. (Refer to the underlined statement above)

Emphasize the importance of the relationship of size and distance of the sun, earth, and moon as well as how the moon orbits around the earth and the earth orbits around the sun.

Have students explore further into the moon's shadow that is created on earth during a solar eclipse (not just the Path of Totality, but also look into the Umbra and Penumbra to realize the different views from earth during an eclipse). Analyze with the students the similar triangles that the moon's shadow creates (such as illustrated in the picture.http://najdesperdu95.blogspot.com/2010/11/total-eclipse.html)



Create the triangles on the classroom model on the wall using tape. Use the actual distances and sizes of the sun, moon, and earth that were recorded on the model from the previous lesson.

Then, show how the shadow creates similar triangles and how you calculate this.
http://spacemath.gsfc.nasa.gov/Modules/6Page28.pdf
The following problem is taken from the link above:

"Problem 3: The sun is 400 times the diameter of the moon. Explain why they appear to have the same angular size if the moon is at a distance of 384,000 kilometers, and the sun is 150 million kilometers from earth?

Answer: From one of our similar triangles, the long vertical side would represent the diameter of the sun; the short vertical side would represent the diameter of the moon; the angle a is the same for both the sun and moon if the distance to the sun from earth were 400x farther than the distance of the moon from earth. Since the lunar distance is 384,000 kilometers, the sun must be at a distance of 154 million kilometers, which is close to the number given."

Vocabulary: Total solar eclipse, partial eclipse, path of totality, ratio, proportional relationship, umbra, penumbra, angular size

ELABORATE: Applications and Extensions:
Show students the projected Path of Totality for the upcoming 2017 Solar Eclipse. Below each video are suggested question to discuss with students during and after each video.

://www.google.com/url?q=https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid%3D4321&sa=D&ust=1465529604486000&usg=AFQjCNGVrQn_oR_e--FiR6rc5LIyCbrquw

Ask students:
Do you notice the umbra and penumbra?
What direction will the shadow be moving across North America?
Will all of America be able to see the total solar eclipse? How do you know? Why or why not?
Will all of America be able to at least see a partial eclipse? How do you know? Why or why not?

https://www.youtube.com/watch?v=HLRVp7IFQAM
Ask students:
Where is a good place to be on August 21st, 2017 if you wanted to witness a total solar eclipse?
Can you find a place close to your home where you could travel to witness this incredible event?

Engage in discussion about how the path was predicted. Students will use their knowledge acquired over the previous lessons to base their ideas/thoughts on how astronomers predict when and where solar eclipses occur.

EVALUATE:
Have students refer back to the questions they recorded in their journals and answer any they may have discovered/learned the answer for.
Students are split up into pairs and given a set of questions.

- How does the sun's position in the sky affect the size and location of a shadow, such as the shadow of a tree or a person?
- Why does a solar eclipse shadow only cover a part of the earth?

Give them a few minutes to note their reasoning into their journals, then discuss among each other and challenge each other's justification for their reasoning.

Elaborate Further / Reflect: Enrichment:

Solar Eclipse Unit: A Shadowy Experience? Lesson Four

Grade/ Grade Band: 7th Grade	**Topic:** Solar Eclipse Classroom Model and News Broadcast	**Lesson #** _4_ **in a series of** __4__ **lessons**

Brief Lesson Description: In this lesson, students will be engaged by a startling situation resembling the solar eclipse. Then, students will be working with Lakota Winter Counts and create a skit to share with the rest of the class and display all they have learned about solar eclipses.

Performance Expectation(s):

Oceti Sakowin Essential Understanding Standard 6: (Analyzing) Grades 6-8: Students are able to compare events recorded on Winter Counts to dates in American History.

Specific Learning Outcomes:

Goal One: Students will understand how science uses evidence to explain the occurrence of a solar eclipse.

Objective Two: Students will use scientific evidence to provide a rational explanation for the occurrences of solar eclipses. (For this measurable goal, students will have completed their Ancient Civilization Legends Chart with accurate conclusions about the Solar Eclipse misconceptions. Students will also produce a news broadcast to demonstrate the knowledge they have gained throughout the unit.)

Narrative / Background Information

Prior Student Knowledge: Students will read background information on the Sioux people, like the Lakota, who kept their historical records on Winter Counts. The Smithsonian website, where students will be able to access the Winter Count collection has brief descriptions available.

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
• Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**N/A**	• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

Possible Preconceptions/Misconceptions: Explain to students, not every Native American culture keeps records on Winter Counts, this process was upheld mainly by Natives of the Great Plains, specifically the Sioux (which includes the Lakota people).

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Note: Students will need access to the internet for this lesson.

Students come in while an eerie event is taking place. (Shut shades, turn off lights, have an object eclipsing a light source, may even add dramatic music.)

Teacher explains to the students: "You are a farmer and you notice eeriness creeping in as shadows appear and colors change. Something strange and somewhat frightful is occurring. You don't know what is going on, but you know something is peculiar. Your chickens retreat to their coop as they begin preparing for the night. Something may seem wrong."

Ask students: Is there something really wrong? Students share responses

Discuss with students that the Lakota knew the solar eclipse was a special event. Lakota have a tradition of recording one major event every year in a "document" called a Winter Count; for example, such as the special time of year that Wi would go and revisit her husband again and the unique relationship of the sun, earth, and moon (which results in the solar eclipse happening on earth).

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Give students step by step instructions on how to access the Smithsonian Winter Count collection.

*When using the Flash 6 version a new window will open with an introduction to Winter Counts (option to skip). Three options will be available "view Winter Counts"-"What are Winter Counts"-"Who are the Lakota" Have students listen to the audio, or explore the tabs that explain who the Lakota/Teton Sioux are, here students will be able to answer questions on "Who are the Lakota". -Where did the Lakota live in North America? -What happened to the Lakota when whites began to settle in the area? -What happened due to treaties being signed by the Lakota?

Next have students explore the "What are Winter Counts" tab and answer a few questions about Winter Counts.-Summarize what a Winter Count is -What is the Lakota word for Winter Count? -What are the responsibilities of the Keeper? -What are Winter Counts usually made out of?

*When using the HTML version a new window will open with few tabs with background information on Winter Counts, the Smithsonian collection, who are the Lakota, social structure, and environment. Have students read and explore the different tabs, while answering a few questions to help gain background information. "What are Winter Counts? What is the Lakota translation for Winter Count? What is a keeper? Where do the Lakota live in North America? -What happened to the Lakota when whites began to settle in the area? -What happened due to treaties being signed by the Lakota?

-Next, students can explore the "view Winter Counts" option. Here students will be shown the entire collection of Winter Counts, listed in chronological order according to their keeper & organized into years. This will help students visualize any similarities among the different Winter Counts; students could also search the years listed on the Winter Counts with any remarkable discoveries that were made in science during the same time.

Students share their findings and anything they thought stood out to them.

*Below the collections there is a search option
-Ask students to look up "stars" to view the different glyphs crested for "year the stars fell" a meteor shower that occurred in 1830s
-Next, have students search for "eclipse" to see the different glyphs created for the eclipse that occurred sometime between 1868 - 1871.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Concepts addressed during the explore section, students should have learned a bit about the Lakota people, and how they keep their winter counts to date. Upon finishing exploring the Smithsonian collection students should have a general understanding of who the Lakota are, where they live, and what a winter count is

Vocabulary:
winter counts-the Lakota version of a calendar, with each snow fall a new glyph is recorded to represent the most important/relevant occurrence of the year (from snowfall to snowfall)

keeper-the man (sometimes can be a woman, but usually is a male) who oversees each family winter count waniyetu wowapi-the Lakota word for winter count, waniyetu means winter, wowapi means paper, together they mean a winter count

glyph-the image/picture that is used on the winter count to represent each year.

ELABORATE: Applications and Extensions:
Go back to the Ancient Civilization Legends chart and fill in anything that is left to be filled in. Encourage students to strengthen their answers in the last column of the chart based on what they learned in their explorations. Students will reexamine the classroom chart, explaining what the people of that culture did not understand about the "eerie event", using their knowledge of the scientific explanation of a solar eclipse. This is where students can explain what their previous explanation was, as compared to what they learned. Hold a classroom discussion where students discuss how solar eclipses evolved from being interpreted as a frightening phenomenon, to something explained through science. Students also discuss the question "Are solar eclipses a shadowy event?"

Sample questions for discussion:
Why did ancient cultures have the beliefs and practices they did surrounding a solar eclipse?
Why/How did the understanding of solar eclipses change?

EVALUATE:
Break students into groups and have them create a "News Broadcast Special Alert: Total Solar Eclipse 2017". In this activity, students act as characters in this news broadcast special alert. Assign or have students volunteer to be astronomers (2+ students) and news broadcasters (2 students) in each group. Have a discussion of the key concepts and terminology learned during this unit. Students are expected to use this terminology correctly throughout their broadcast. (An optional rubric is attached to this unit)

Elaborate Further / Reflect: Enrichment:
Ask students to write a short story, at least 1-2 pages with a writing prompt, for example "If I were an eclipse chaser…" and have them elaborate on what their process would be to prepare for chasing an eclipse. Students would be able to get creative while still addressing the key terminology discussed throughout the entire instructional unit.

Handout of Ancient Beliefs on Total Solar Eclipses

Chinese and Vietnamese
-Chinese and Vietnamese believed long ago that it was demons who ate the sun!

Hindy
-Also believed that demons ate the sun as well. They actually believed by banging on pots and pans they could cause the demon to be frightened away!

Bear-eating Sun
-North Americans had a legend of a bear who got into a fight with the sun, and actually took a bite out of the sun! (Went on to fight with the moon as well, causing lunar eclipse. Which is the opposite of a solar eclipse).

Italy
-In modern day Italy, people believe that planting flowers during an eclipse can ultimately lead to the flowers blooming into brighter than usual and more colorful!

Time for Reconciliation
-Some believed the people on earth had to resolve their differences in order for the moon to unblock the sun.

Don't Go Outside!!
-Even today, some people believe it is bad luck for women who are pregnant as well as children to go outdoors during a solar eclipse.

India
-People in India, believe any food cooked during a solar eclipse could possibly be poison!

http://sunearthday.nasa.gov/2006/multimedia/storyteller.php
This resource also gives different myths and misconceptions about solar eclipses as Jordan Hill gives them in a storytelling format. This is a great way for students to learn about different myths as it is a different format than just research on the subject.
There is a video and short description for each story. He is very engaging and I think your students would enjoy this!

References:

"8 Brilliant Myths Which Come with a Solar Eclipse." *BT.com*. N.p., n.d. Web. 10 June 2016. <http://home.bt.com/news/science-news/8-brilliant-myths-which-come-with-a-solar-eclipse-11363968544220>.

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