Rachel Amento and Lindsay Waack

Eclipse Unit

Grade/ Grade Band: Grades 6-8	Topic: Eclipses	Lesson # Pre 1 in a series of 4 lessons

Brief Lesson Description: This lesson serves as a pre-activity to a model-based unit. If the scientific skill of modeling has not been explicitly taught or used frequently in your classroom, it is suggested that you complete this lesson first with your students so they understand how to use this skill as they go through the unit. Students learn what the scientific skill of modeling is and what makes a model good through completing a station activity. Each station will have different examples of models explaining the phenomenon of moon phases. Students will work in small groups to identify which models they believe are the best and what aspects of the model makes them the best.

Performance Expectation(s):

NGSS 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.
Essential Questions (EQs): *Practice-based*: What is a model, what is modeling and how is it used in the scientific community? How can we use it in our classroom? What are the characteristics of a **good** model? *Content-based*: How can we use a model to better understand total solar eclipses?

Specific Learning Outcomes:

Become comfortable with NGSS Practice - Develop and Use Models and the expectations of how they are to use models. Modeling in grades 6–8 builds on grades K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. (Bloom's Level 3 - Application)
- Evaluate limitations of a model for a proposed object or tool.
- Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed.
- Use and/or develop a model of simple systems with uncertain and less predictable factors.
- Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
- Develop and/or use a model to predict and/or describe phenomena.
- Develop a model to describe unobservable mechanisms.
- Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs and those at unobservable scales. (NGSS, Appendix F, p. 53)

Narrative / Background Information

Prior Student Knowledge: Planets, moon, solar system, light and shadows. Day and night, rotation of the Earth, moon phases.

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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 (lunar phases, eclipses). (MS-ESS1-1), (MS-ESS1-2)	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. (MS-ESS1-1)	*Systems and System Models -* Models can be used to represent systems and their interactions. (MS- ESS1- 2) AND/maybe *Patterns -* Patterns can be used to identify cause and effect relationships. (MS- ESS1- 1)

Possible Preconceptions/Misconceptions: Sun orbits the Earth, Earth orbits the Moon, models are just pictures.

LESSON PLAN – 5-E Model

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

<u>Learning about models - the what, how, and why</u>: Brief presentation on what scientific models are, how they are used in the scientific world and how they can be used in the classroom, and why they are important to communicating and furthering scientific understanding. Information will be acquired mainly from the NRC Framework and NGSS, open conversation should be had about the standards that students are being held to both during this lesson and throughout the year. This information will then be applied to the specific example of lunar phases. Six different examples that model lunar phases will be placed around the room in different stations. Students will dissect the models using the information from the beginning of class to judge whether or not it is a good model.

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

Show examples of a how models can help explain a phenomenon with examples of lunar phases models. Students will explore multiple versions of models of the phenomena and discover what part of each model explains the phenomenon well and which ones need improvement.

Questions to consider when exploring models: What makes this model effective? What does this model explain well? What needs to be explained better in this model? Does this model show change over time?

EXPLAIN: Concepts Explained and Vocabulary Defined:

The class will review what they thought were good aspects of each model.

Vocabulary: Models/Modeling

ELABORATE: Applications and Extensions:

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Teacher should have a Q & A session afterwards to ensure student understanding.
EVALUATE: Exit slip: Students will be given an image of a new model and they will explain what makes it a good model or how it can be improved.
Elaborate Further / Reflect: Enrichment: Students can be challenged by more difficult models if necessary.

Materials Required for This Lesson/Activity			
Quantity	Description	Potential Supplier (item #)	Estimated Price
5	Images of models for station work (1 per station)		

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Eclipse Unit

Grade/ Grade Band: Grades 6-8	Topic: Eclipses	Lesson # 1 in a series of 4 lessons

Brief Lesson Description: After watching the Alaskan Airline video, students work together in small groups to come up with an initial model to explain the phenomenon of solar eclipses. Students then share their model with another group and offer criticism and comments to each other. Students should also be noticing similarities and differences between their models to come up with a classwide list of themes and questions that relate to initial models.

Performance Expectation(s): **NGSS 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. **Essential Questions**: *Content-based*: How can we use a model to better understand total solar eclipses?

Specific Learning Outcomes:
Become comfortable with NGSS Practice - Develop and Use Models and the expectations of how they are to use 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. (Bloom's Level 3 - Application)
    - Evaluate limitations of a model for a proposed object or tool.
    - Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed.
    - Use and/or develop a model of simple systems with uncertain and less predictable factors.
    - Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
    - Develop and/or use a model to predict and/or describe phenomena.
    - Develop a model to describe unobservable mechanisms.
    - Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs and those at unobservable scales. (NGSS, Appendix F, p. 53)

Narrative / Background Information

Prior Student Knowledge: Planets, moon, solar system, light and shadows. Day and night, rotation of the Earth, moon phases, modeling.

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	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. (MS-ESS1-1)	*Systems and System Models* - Models can be used to represent systems and their interactions. (MS- ESS1- 2) AND/maybe *Patterns* - Patterns can be used to identify cause and effect relationships. (MS- ESS1- 1)

use a model to describe phenomena (lunar phases, eclipses). (MS-ESS1-1), (MS-ESS1-2)		

Possible Preconceptions/Misconceptions: Sun orbits the Earth, distance, size and relative location of the Earth, Sun, and Moon, which objects cast shadows and which objects create light.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
Watch Alaskan Airlines video of solar eclipse viewers:
https://www.youtube.com/watch?v=YBoa81xEvNA

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Initial Model: In small groups, no larger than 4, students will work together to create an initial model that explains how the Earth, Sun, and Moon interact with each other to create the phenomenon of a total solar eclipse. (20 minutes)

EXPLAIN: Concepts Explained and Vocabulary Defined:
Turn & Share: Students share initial models within small group to group conferences and explain how their models describe the phenomenon of a total solar eclipse and adhere to the definition of a good model as defined earlier in class.

Vocabulary: Eclipses, solar eclipse

ELABORATE: Applications and Extensions:
As a class, come up with list of themes and questions that allow students to identify important patterns and create investigations surrounding topics they need to learn more about.

EVALUATE:
Exit Slip: On a post-it note, write a critique about your own model. What is something your model describes well? What is something your model can improve upon? Put your post-it note on your model so it's there when we come back to them. (5 minutes)

Materials Required for This Lesson/Activity			
Quantity	**Description**	**Potential Supplier (item #)**	**Estimated Price**
1 Per Group	Large paper to create initial model		

1 Per Group	Writing utensil to make model		
1 Per Person	Post-it note for exit slip		

Eclipse Unit

Grade/ Grade Band: Grades 6-8	Topic: Eclipses	Lesson # 2 in a series of 4 lessons

Brief Lesson Description: In this lesson students will address current understanding of gravity and orbit and then explore a PhET simulation to discover how gravity impacts the orbits of planetary bodies. Students will complete a guided worksheet that focuses on how distance, mass, and gravity relate to each other and impact the orbits of the Earth and Moon around our Sun.

Performance Expectation(s):

NGSS 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.

Essential Questions: How do we know gravity exists? What are the effects of gravity that we see and experience? How does gravity shape the bodies and their movements in our Solar System - why is this important? Between the Earth, Sun, and Moon, which object orbits the Earth? The Sun? The Moon? How does gravity affected who orbits who?

Specific Learning Outcomes:

1. Understanding the effects of gravity and its impact on how we observe motion in space (Bloom's Level 3 - Applying)

2. Orbits and the natural variations of orbits are predictable (*Embedded in LO-1*) (Bloom's Level 2 - Understanding)

Narrative / Background Information

Prior Student Knowledge: Planets, moon, solar system, light and shadows. Day and night, rotation of the Earth, moon phases, modeling.

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 (lunar phases, eclipses). (MS-ESS1-1), (MS-ESS1-2)	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. (MS-ESS1-1)	*Systems and System Models* - Models can be used to represent systems and their interactions. (MS- ESS1- 2) AND/maybe *Patterns* - Patterns can be used to identify cause and effect relationships. (MS- ESS1- 1)

Possible Preconceptions/Misconceptions: Sun orbits the Earth, gravity pulls objects downwards, orbits are perfect circles.

LESSON PLAN – 5-E Model

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ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
Quickwrite: What do you think gravity is? How have you experienced or observed gravity? What is an orbit? What are some objects you know of that orbit? (5 minutes)   Turn & Talk: Turn to the person next to you and share the answers you've written down. Are there differences? Similarities? (5 minutes)   Class Share Out: What did your conversations with your partners bring up? Did they make you think about gravity or orbits in a new and different way? (5 minutes)
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Gravity and Orbit PhET Simulation: With a partner, students will work explore the simulator and complete a guided worksheet. (40 minutes)   Simulator: http://phet.colorado.edu/en/simulation/gravity-and-orbits
EXPLAIN: Concepts Explained and Vocabulary Defined:
Class Share Out: Classwide share out of findings from simulation with emphasis on how students initially defined gravity and orbits in comparison to how they defined them after using the simulator and completed the worksheet. Class discussion is intended to address misconceptions, particularly any that appeared during the initial class share out, and reference how the simulator helped to dispel these or could be used to dispel them. (20 minutes - if longer, that's okay! As long as discussion is kept focused)   **Vocabulary:** Gravity, orbit
ELABORATE: Applications and Extensions:
Applying the idea of orbits and gravity to your model, how will you incorporate these concepts?
EVALUATE:
Guided worksheet
Elaborate Further / Reflect: Enrichment: Explore other parts of the PhET simulation

Materials Required for This Lesson/Activity			
Quantity	**Description**	**Potential Supplier (item #)**	**Estimated Price**
1 Per Pair	Computer to run PhET simulation		
1 Per Person	Attached Worksheet		

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Eclipse Unit

Grade/ Grade Band: Grades 6-8	Topic: Eclipses	Lesson # 3 in a series of 4 lessons

Brief Lesson Description: Students will conduct a shadow inquiry lab by using light sources and objects of different sizes (one simulating Earth and another simulating the Moon) at varying distances to gain an understanding about the relationship between size and distance and shadow cast.

Performance Expectation(s):
NGSS 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.
Essential Questions: Where does the moon get "its" light from? How are shadows made? Do shadows exist in space? What shadows exist in space to make the moon go dark? How do we measure and observe light and shadows in space and what consistent patterns does this create?

Specific Learning Outcomes:
1. Larger objects will cast larger shadows than smaller objects.
2. As an object moves away from a light source, its shadow becomes smaller.
3. As an object moves closer to a light source, its shadow becomes larger.
4. Why the moon needs to be between the Sun and Earth to create a solar eclipse

Narrative / Background Information

Prior Student Knowledge: Planets, moon, solar system, light and shadows. Day and night, rotation of the Earth, moon phases, modeling, gravity, and orbits.

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 (lunar phases, eclipses). (MS-ESS1-1), (MS-ESS1-2)	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. (MS-ESS1-1)	*Systems and System Models* - Models can be used to represent systems and their interactions. (MS- ESS1- 2) AND/maybe *Patterns* - Patterns can be used to identify cause and effect relationships. (MS- ESS1- 1)

Possible Preconceptions/Misconceptions: Sun orbits the Earth, all objects cast a similar looking shadow, Earth comes between the Moon and Sun during a solar eclipse

LESSON PLAN – 5-E Model

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ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: Presentation going over various 'to scale' descriptions of the Earth-Sun-Moon sizes and distances. Best if accompanied with pictures or real-life objects. (5 minutes)

(Information: http://www.pha.jhu.edu/~wpb/scale.html)
<u>Solar System Scale:</u>

Solar System Scaled to 12-inch Sun

Parameter	Real Distance/Size	Scaled Distance/Size
Sun (diameter)	1,392,000 km	12 inches (basketball) or
Mercury (distance)	0.39 AU	41.5 feet
Mercury (diameter)	4880 km	0.05 inches (grain of sand)
Venus (distance)	0.72 AU	76.6 feet
Venus (diameter)	12112 km	0.11 inches (small pebble)
Earth (distance)	150 million km = 1 AU	106.4 feet
Earth (diameter)	12,756 km	0.12 inches (small pebble)
Mars (distance)	228 million km	163.6 feet
Mars (diameter)	6,800 km	0.06 inches (grain of sand)
Jupiter (distance)	5.20 AU	552 feet
Jupiter (diameter)	142,984 km	1.2 inches (ping pong ball)
Saturn (distance)	9.54 AU	1012 feet (>3 football fields)
Saturn (diameter)	120,536 km	1.04 inches (ping pong ball w/rings!)
Pluto (distance)	39.54 AU	4200 feet (almost 0.8 miles)
Pluto (diameter)	2,300 km	0.02 inches (very small sand grain!)

Next nearest star	4.3 light years =	5680 miles(!) or 9088 km
(Proxima Centauri)	25 trillion miles =	(roughly from Baltimore to Hawaii!)
	42 trillion km	

<u>Earth-Sun-Moon Scale:</u>

Scaled to 16 inch Earth

Parameter	Real Distance/Size	Scaled Distance/Size
Earth (diameter)	12,756 km	16.0 inches
Moon (diameter)	3,476 km	4.4 inches
Moon (distance)	384,400 km	40.2 feet
Sun (diameter)	1,392,000 km	145.5 feet
Sun (distance)	150 million km	15,700 feet = nearly 3 miles!

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EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
<u>Shadow Inquiry Lab</u>: Working in small groups, students will use basic materials to create their own lab to figure out how shadows are created and what effects their characteristics (size and darkness). Inquiry will be based off of research question, What factors affect the size of a shadow? (55 minutes)

EXPLAIN: Concepts Explained and Vocabulary Defined:
Review the guided worksheet to help explain the factors that affect shadow. **Vocabulary:** Astronomical Unit, Light Year, Eclipse

ELABORATE: Applications and Extensions:
<u>Connecting Inquiry to Astronomy</u>: Through a classwide discussion, connect the inquiry lab to how light and shadows act in space, specifically considering our Sun, Earth, and Moon. Below are some key guiding questions to help connect the inquiry activity to space: (15 minutes)

EVALUATE:
<u>Assess for student understanding</u>: On post-it note, write down one way that you could use the information you've learned about lights and shadows to improve your model from day 1. (5 minutes)

Elaborate Further / Reflect: Enrichment:
<u>Enrichment question on worksheet</u>: Everyday our sun travels across the sky rising in the East and setting in the West. Every night our Moon travels a similar path, also rising in the East and setting in the West. The apparent motion of both of these planetary bodies is due to the rotation of Earth which rotates East→West. However, during the total solar eclipse of 2017, the shadow of totality will travel across the continental US from Oregon to South Carolina in a West→East direction. How does this happen? Use the lab materials to help explore this idea.

Materials Required for This Lesson/Activity			
Quantity	**Description**	**Potential Supplier (item #)**	**Estimated Price**
2	Flood lights / Light Point Source		
1 Per Group	Large round object (Earth) Volleyball or softball good for relative size		
1 Per Group	Small round object (Moon) Softball if using volleyball or ping-pong ball if using softball as Earth		
1 Per Person	Attached worksheet		
1 Per Person	Post-it note for exit slip		

Eclipse Unit

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Grade/ Grade Band: Grades 6-8	Topic: Eclipses	Lesson # 4 in a series of 4 lessons

Brief Lesson Description: Students will revisit their models and work to describe the phenomenon of a total solar eclipse by including information learned over the last few days; light and shadow, gravity and orbit, alignment of planetary bodies during the event. After revisions are complete, students will reflect on each other's work.

Performance Expectation(s):
NGSS 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.
Essential Questions: How do we know about the 2017 solar eclipse already? How do we know it's exact path?

Specific Learning Outcomes:
1. Observational manifestations of Earth/Moon movements (what phases/eclipses *look* like, what they cause us to experience on Earth) (Bloom's Level 5 - Evaluating)
2. Darkness on the Moon or Earth during an eclipse is caused by the Earth's or Moon's shadow and is dependent on the relative position of the Earth and Moon (Bloom's Level 3 - Applying)

Narrative / Background Information

Prior Student Knowledge: Planets, moon, solar system, light and shadows. Day and night, rotation of the Earth, moon phases, modeling, gravity and orbits, relative sizes and locations of Earth, Sun, and Moon.

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 (lunar phases, eclipses). (MS-ESS1-1), (MS-ESS1-2)	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. (MS-ESS1-1)	*Systems and System Models* - Models can be used to represent systems and their interactions. (MS- ESS1- 2) AND/maybe *Patterns* - Patterns can be used to identify cause and effect relationships. (MS- ESS1- 1)

Possible Preconceptions/Misconceptions: Sun orbits the Earth, distance, size, and relative location of the Earth, Sun, and Moon

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
<u>Revisiting Initial Models</u>: Go back to the initial model and make any modifications that are needed based off of the past few days. Lab materials from the previous day can be utilized to test models.

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EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
<u>Gallery Walk</u>: Final models will be displayed throughout the classroom, allowing students to observe how their peers modeled the phenomena. Students will leave feedback on post-it notes about positive aspects of models and suggestions for improvement based off of information they learned on Day 1 about the process of modeling. (20 minutes)

EXPLAIN: Concepts Explained and Vocabulary Defined:
<u>Defending Their Model</u>: In their small groups, students will create an explanation as to why and how we experience lunar phases and eclipses and how their models explain this accurately. (20 minutes) <u>Turn and Talk</u>: Given all of the information we've depicted in our models and have learned the past couple of days turn to a partner and discuss the following: How do we know about the 2017 solar eclipse already? How do we know it's exact path? (5 minutes)   **Vocabulary:** eclipse, solar eclipse, lunar eclipse

ELABORATE: Applications and Extensions:
What are the positions of the Earth, Sun, and Moon during a lunar eclipse? Solar eclipse? What phase of the moon occurs during a lunar eclipse? Solar eclipse? Can this ever be different, why or why not? What does an event like a total solar eclipse mean for scientists? What are we able to observe during this event that we normally cannot?

EVALUATE:
Accuracy of final model and student defense of model.

Elaborate Further / Reflect: Enrichment: Eclipse-viewing safety (pin-hole camera activity)

Materials Required for This Lesson/Activity			
Quantity	**Description**	**Potential Supplier (item #)**	**Estimated Price**
	Initial Models and other worksheets to support the creation of the final model		
1 per Group	Paper to create final models		
1 per Group	Writing utensil to create final model		
	Tape to hang models throughout classroom		