Eyes on Earth: Teaching Earth Science from Space - 5E Integrated STEM Lesson Plan

Lesson Title: *Sun, Earth & Moon System Scope*

Author: *Kayla Brooks*

Topic: *Students will learn the main topics of:*

- Lunar Cycle
- Seasonal Tilt and Whirl
- Eclipses
- Cycles of the Earth, Moon, and Sun

Targeted Grade Level: *8th Grade Science*

Time Needed: To fully complete the 5E scope of learning it will take about a week-an-a-half to two weeks since there are four explore activities to do. The first explore, the lunar cycle, will take at least two days to complete thoroughly (160-220 minutes). After that, the lessons will move at their own pace, at hopefully no more than 2-3 hours per section of the lesson.

Subject Integration: *There are no common core math alignments with these lessons but there is a math connections page that can be done in the elaborate section.*

Standards:

NGSS Performance Expectations 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.

Clarification Statement: Examples of models can be physical, graphical, or conceptual.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:

Developing and Using Models *Develop and use a model to describe phenomena (MS-ESS1-1)* Students will develop and use models in Explores 1, 2, & 3.	***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)* Students will be able to do this in Explores 1, 2, and 3. ***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 directions 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 cross the year. (MS-ESS1-1)* Students will see this in Explore 2, "seasonal tilt and whirl".	***Patterns*** *Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1)* Students will see patterns in all four explores.
Common Core State Standards: *California has adopted NGSS science standards since 2013.*		

Math: MP.4 Model with mathematics.

Ask students what might happen if the Moon's plane of orbit was the same as the plane of Earth's orbit revolving around the Sun. Instruct students to look at the model and imagine that the planes were the same. Have students write a sentence to explain the relationship between solar eclipses and lunar eclipses.

Math extensions could be:

- Have the students expand on their models by determining how much more mass Earth has than the Moon and the Sun has than Earth.
- Have them find the masses of each of these celestial bodies, using scientific notation.
- Then have them determine how many more time larger Earth is than the Moon and the Sun is than Earth.
- Have them find the percentage difference between Earth and the Moon.

ITEEA Standards

- Identify trends
- Interpret and evaluate accuracy of information
- Modeling, testing, evaluating, and modifying

Measurable Student Learning Objectives:

In Explore 1 "Lunar Cycle" students will be able to:

1. Make observations based off of the "moon on a stick" model they created and draw their observations on their student handout.
2. Answer questions orally and on their handout.
3. Conversate with their partners and class through Nearpod's discussion board and will then refine their thinking on their phenomena table.

In Explore 2 "Seasonal Tilt and Whirl" students will be able to:

1. Make observations on an Earth/Sun model and record their opinions on their student handout after discussing as a class.
2. Add to the classroom discussion on what causes day and night, what causes seasons, what does Earth rotate around, etc.
3. Use their earth/sun model in their groups and make inferences to what season occur at specific points due to the Earth's tilt.
4. Create their own definitions for the vocab words seasons, poles, axis, orbital path, revolution, tilt, etc.
5. Add to their phenomena question on their handout which is taped in their Interactive Science Notebook.

In Explore 3 "Eclipses" students will be able to:

1. Use a human model of the sun-earth-moon system to model the relative positions of the objects during solar and lunar eclipses.
2. Diagram the phenomena on their handout.
3. Create/add to the definitions for the vocab words lunar eclipse, solar eclipse, solar energy, celestial objects, etc.
4. Add to their phenomena table handout after the explore is finished, classroom discussions will occur after.
5. Math extension can be done where students would be able to include the distances between each celestial body in their model and then determine the correct scale of their models.

In Explore 4 "Tuva – Cycles of the Moon, Earth, and Sun" students will be able to:

1. Manipulate an online dataset to analyze and interpret data on eclipses and seasons
2. Use their handout to answer questions based off of data from the TUVA

Nature of STEM: As students explore and determine the cause of seasons experienced on Earth, they will be exposed to the idea that science assumes that objects and events in natural systems occur in consistent patterns that are understandable through observation and measurement.

Engaging Context/Phenomena:

Anchoring Phenomena Event: Show students a video of someone carrying a compass around Earth and have them observe what happens. **Anchoring Phenomena Driving Question:** How can an object influence the motion of another object without touching it? (This will take many weeks to answer this Segments question).

Investigative Phenomena for this scope: Open up NASA's app Eyes on the Solar System and show Jupiter and it's moons orbiting each other at the speed of 1hr(s)/sec. **Question:** Have you ever wondered if other moons in our solar system have phases? (This question will be answered at the end of this 2-week scope).

Data Integration: Data that will be used by the students will come from NASA's Eye on the Solar System app and from the TUVA data set found in Explore 4.

Differentiation of Instruction: For English language development we could do a say it again activity where students repeat back the meaning of a scientific observation/fact but in a different way. For example, "The moon is waxing when it's getting bigger each night. Then students say it again using different words such as, "A waxing moon grows larger every day. After the fact has been restated several times, the teacher can move on to another one until the teacher has done three to five facts restated three to five times each. For difficulty learning new vocabulary, students can come up with their own rhyme or song to learn the moon phases. (This is embedded already in the explores and will be done in the explain section).

Real-life Connection: Seasons – all students have experienced different seasons at this point in their lives. Shadows – students have experienced casted shadows from different objects and have seen them shift throughout the day. Stars – students can look up into the night sky and observe constellations. Celestial bodies – students have experienced the sun and moon, etc. Tides – some students may have experienced the rise and fall of sea levels based on if they have lived near the coast or have visited on vacation. Lunar/solar eclipses – rarer, but some students may have had experiences with this phenomena. Indigenous ways of knowing – Sky stories. Connections could be made to indigenous people's beliefs of communication between mortals and the spiritual world, etc.

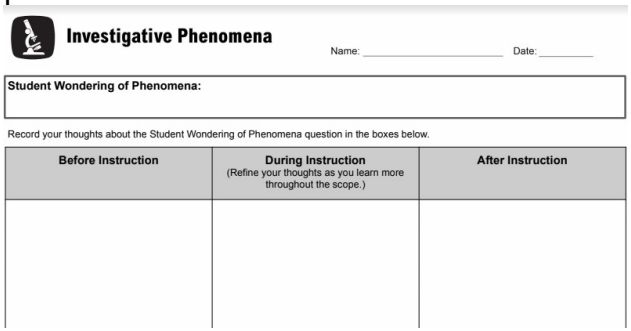
Possible Misconceptions:

- Students may not understand that the Moon is visible during the day as well as at night.
- Students may not understand that the Moon does not produce its own light.
- Students may believe the stars are moving in the night sky based on their perspective on Earth.
- That the Earth experiences different seasons based on how close or far it is in distance from the sun.
- Other celestial bodies do not have gravity.

- Etc.

Lesson Procedure: The Engage and Explore 1 will be explained in detail for this assignment, and the rest of the explores will be briefer but handouts and assessments will be attached when possible. This lesson plan is mainly for Explore 1 and to show where that lesson would connect to the other ones later in the week(s).

5E Model	5E Objectives
Engage ***Anchoring Phenomena Event:*** *Show students a video of someone carrying a compass around Earth and have them observe what happens.* ***Anchoring Phenomena Driving Question:*** *How can an object influence the motion of another object without touching it?* ***Investigative Phenomena for this scope:*** *Open up NASA's app Eyes on the Solar System and show Jupiter and it's moons orbiting each other at the speed of 1hr(s)/sec.* ***Question:*** *Have you*	**Materials:** • Teacher will need a computer with access to Nearpod and Eyes on the Solar System app (ESS). • Students will need an electronic device to access Nearpod and the ESS app. **Procedure:** Teacher's role during this phase – 1. Check that all technology is working prior to students coming in and write the Nearpod code on the board. (If there is an internet shutdown, this lesson can be trimmed down to just verbal discussion, whiteboard drawings, and the explore 1 activity and still be completed). 2. Write the phenomena questions on the board. 3. Inside the Nearpod lesson, click and show the compass phenomena video and ask students the anchoring phenomena question. Allow students to process the question, then have them think, pair, share. Accept all answers and explain that students will be able to answer this question at the end of the segment (many weeks of lessons). 4. Continue through Nearpod lesson and click on the external link that will bring you to NASA's Eyes on the Solar System app. (If link doesn't work, type it into the search bar and the free app will show up, it is also downloaded to my computer). Have a student dim the lights. 5. Click on advanced mode and zoom into Jupiter and its orbit. Switch the speed to 1-2hr(s)/sec. Under visual controls switch slowly between the zoomed in view, ride-along

ever wondered if other moons in our solar system have phases?	view, and zoomed-out view. 6. Ask students for their observations on the celestial bodies. Then ask them the investigative phenomena question *"Have you ever wondered if other moons in our solar system have phases?"* SWBAT answer this question by the end of this scope of learning (1-2 weeks). 7. Have students quickly discuss their thoughts on the answer. Have them write and fill in their phenomena table in the "before instruction" box and the question in the top section.  **Investigative Phenomena** Name: _____ Date: _____ **Student Wondering of Phenomena:** Record your thoughts about the Student Wondering of Phenomena question in the boxes below. **Before Instruction** | **During Instruction** (Refine your thoughts as you learn more throughout the scope.) | **After Instruction** 8. Allow time for students to explore the NASA app (10 minutes) and allow them to make discoveries and create a sense of wonder. **Modifications:** For students with writing disabilities, students can orally discuss their thoughts with the teacher and group. If tech doesn't work, Jupiter and its orbiting moons can be drawn on the white board and named and discussion can occur this way. **Standards Addressed** No standards are being taught in this Engage section, but it will reference to the NGSS standard **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. *Clarification Statement: Examples of models can be physical, graphical, or conceptual.* **Formative/Summative Assessments** Students will be formatively assessed by their oral discussions in class and their written work on their phenomena table. **Resources** *NASA's Eyes*. (n.d.). Https://Eyes.Nasa.Gov/. Retrieved September 22, 2020, from

	https://eyes.nasa.gov/
Explore 1: Lunar Cycle **Everyday Phenomena**: How does the Earth, Sun, and Moon system cause the lunar cycle? (Write this on the board)	**Procedure:** Teachers preparation before lesson – 1. Print one copy of Lunar Cycle for each student in your class. 2. Prepare a "Moon on a Stick for each student by using a foam ball and pencil. 3. Set up the lamp with a 150-watt light bulb in a large space for the students to stand in a circle around the lamp (without anyone between the students and the lamp). The bulb of the lamp must be at student head level while standing. Use the extension cord, if necessary, and tape the cord onto the floor to lessen the tripping hazard. 4. Darken the room as much as possible by covering all windows and doors with black paper. The room must be dark. Black butcher paper or large, black, heavy plastic garbage bags could work. 5. Students will need a hard surface to write on like a clip board or their notebooks. Teacher's & students' role during this explore – (Part 1) 1. Have students get organized and have their notebooks, paper, pencil, and clipboard ready 2. Discuss expectations, if necessary, for how they will act once lights are off and they are standing in a circle 3. Turn on the lamp and turn off any other lights in the room once the students are in position around the lamp. 4. Tell students to not answer the phase name portion of the Lunar Cycle during this activity. 5. Ask students to observe and report verbally to the group how much light they see on their Moon. (They should not see any light at this point). 6. Tell students to complete question 1 in their student handout. Review as a class. Draw the portion of the Moon that is lit when you are facing the light source. Students should completely shade in the circle. *If you are Earth, where is the Sun (light source) in relation to*

	the Moon at this phase? 7. Tell students to keep their Moon in front of them and slowly rotate to their left, making one-eighth of a turn. Model this motion to show the students how to make one-eighth turns. Ensure that students face the correct direction throughout the activity. Again, ask the students to observe and report how much light they see on their Moon. 8. Tell students to complete question 2 in their student handout. Review as a class. Draw the portion of the Moon that is lit after you have rotated one-eighth of a turn to your left. *Is the Moon moving toward or away from the Sun?* 9. Instruct students to keep their Moon in front of them and rotate their body to the left until their right shoulder is pointed towards the light source. 10. Tell students to complete question 3 in their student handout. Review as a class. Draw the portion of the Moon that is lit when your right shoulder is pointed toward the light source. *How much of the Moon is lit and seen from Earth?* 11. Tell students to keep their Moon in front of them and rotate to their left again, making another one-eighth turn. Tell students to complete question 4 in their student handout. Review as a class. Draw the portion of the Moon that is lit after you rotated one-eighth of a turn to your left. *Is the amount of the Moon lit getting larger or smaller?* 12. Instruct students to hold their Moon up so that their shadow does not fall on their Moon and rotate to their left until the light source is directly behind them. **Teacher Note: This step is tricky because the students need to hold their Moon models so that the shadows of their heads do not block the light from the lamp. If students encounter this problem, remind them to hold their Moons above the shadow of their Earth head. 13. Tell students to complete question 5 in their student handout. Review as a class. Draw the portion of the Moon that is lit when you are standing with your back to the light source. Students should not shade anything. *How much of the Moon facing Earth is lit?* 14. Hold your Moon in front of you again while you rotate to your left, making one-eighth of a turn. 15. Tell students to complete question 6 in their student handout. Review as a class. Draw the portion of the Moon that is lit after you rotated one-eighth of a turn to your left. Only a small crescent shape should be shaded on the right of the Moon. *Is the Moon moving toward the Sun or away from the Sun?* 16. Holding your Moon in front of you, rotate to your left until your left shoulder is pointed towards

	the light source. 17. Tell students to complete question 7 in their student handout. Review as a class. Draw the portion of the Moon that is lit when your left shoulder is pointed toward the light source. *How much of the Moon is lit and seen from Earth?* 18. Tell students to continue holding their Moon in front of them as they rotate to their left, making one-eighth of a turn. 19. Tell students to complete question 8 in their student handout. Review as a class. Draw the portion of the Moon that is lit after you rotated one-eighth of a turn to your left. *Is the amount of Moon lit getting larger or smaller?* 20. Instruct students to return to facing the lamp. Tell them they have completed one lunar cycle. 21. Ask: What do you think the term lunar phases mean? Accept all answers. 22. Introduce the definition for the vocabulary term “lunar phases”. 23. Instruct students to answer the remaining questions in Part I of their handouts. Tell them they may redo any parts of the model as needed to answer the questions. Keep the light source as the only light in the room until the students do not need to use the model to complete their answers. 24. Review questions 9-22 with students. (Part 2) 1. Ask: *What side of the Moon lights up first each lunar cycle?* Tell students an easy way to remember this is the rhyme, “Light on the right.” 2. Have students draw and label the Moon’s phases on the diagram. Instruct them to draw what they would see if they were standing on the Earth and looking at the Moon. The Sun’s position is at the top of the page (and VERY far away!). 3. Have students begin with the New Moon and draw each phase as it can be predicted by the cyclical movements between the Earth, Moon, and Sun system. Student diagrams should match the diagram in the handout key. 4. Have students look at the diagram titled “Revolution and Phase”. The outer diagrams of the Moon show the moon phases as if seen in that position from Earth. *Why are the shadow positions of the Earth and all the Moon diagrams of the inner circle the same?* (Reflections & Conclusions)

	1. Instruct students to answer the questions independently 2. After 90% of students have completed the answers, review the last questions 1-7 as a class. 3. Make connections to the Investigative phenomena table and have students write in the middle “during instruction” box. **Modifications** If there are students who are wheelchair bound, make sure that enough space is given to them for them to rotate around smoothly. Make sure that the lamp height is good for them to complete this activity. **Standards Addressed** 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. **Formative/Summative Assessments** Teacher will hold class discussions and see if students still hold misconceptions or not. Students will be writing in their phenomena tables, which are looked over by the teacher to see as they progress through the scope of learning. **Resources/Materials** • 1 shade-less lamp • 1 150w light bulb • 1 extension cord • 36 pencils • 36 foam balls • Black paper (as needed to make room dark) • Tape • Lunar Cycle explore 1 handout
Explore 2: Activity – Seasonal Tilt and Whirl **Everyday phenomena Question:** How does the	**For Explores #2-4 I will be brief since it is not required to have multiple and I don’t want the document getting too long. My resources I am using for all of the explores comes from my school’s curriculum STEMscopes, which I cannot cite in APA format.** **Explore 2:**

Earth, Sun, and Moon system cause the seasons? (Write this on the board). **Explore 3: Eclipses** **Everyday phenomena question:** How does the Earth, Sun, and Moon system cause eclipses? (Write on the board)	**Procedure:** Procedures are found on this document with answers included. **Standards Addressed** 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. **Formative/Summative Assessments** Their handout will be graded and classroom discussions will be formatively evaluated. **Resources** Student handout **Explore 3:** **Procedure:** Procedures are found on this document with answers included. **Standards Addressed** 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. **Formative/Summative Assessments** Their handout will be graded and classroom discussions will be formatively evaluated. **Resources** Student Handout.
Explore 4: TUVA – Cycles of the Moon, Earth, and Sun **Everyday phenomena question:** How can we predict eclipses and	**Explore 4:** **Procedure:** Procedures are found on this document. Students will need access to STEMscopes website to access the TUVA dataset. **Standards Addressed** MS-ESS1-1: Develop and use a model of the Earth-sun-moon system to

number of daylight hours? (Write on board). **Explain**	describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. **Formative/Summative Assessments** Their handout will be graded and classroom discussions will be formatively evaluated. Their CER will be graded at the end as well. **Resources** Student Handout **Procedure:** Students will create a vocab foldable with the vocab words used from this scope of learning found here. This vocab card shuffle that is attached can then be a great starter activity at the beginning or end of a class. Students will also receive a STEMscopedia article that they will need to read, annotate, and write a summary on. It will be graded. **Modifications** There are 3 different reading levels for the article and students will receive the article that is at their reading level. **Standards Addressed** Same standard that's been used the whole time. **Formative/Summative Assessments** Their vocab foldables will be done at home, taped into their ISN's and graded with a stamp. Their article annotations will be graded by partners but then ultimately graded by teacher. **Resources** STEMscopedia Article that I got from my online curriculum.
Elaborate There are 11 different Elaborate activities that my curriculum gives to me as options. Many can be printed and left for subs to easily	**Resources** • Math elaborate paper • The other resources are either videos, games, or data sets that I can not link on this document. **Evaluate – All types of assessments are aligned to the standard that was taught for this**

administer. **Evaluate**	**scope.** 1. CER Link that is like an exam for the end of a scope. 2. Open-ended response exam 3. Multiple Choice quiz

Teacher Background for this entire scope:

https://docs.google.com/document/d/1BbV4iymF3tH0ByB2MqrhvyfgYx9n6PVd6BEFAqJ0D3I/edit?usp=sharing

Resources used in the making of this 1-2 week lesson plan:

NASA, K.H., S.K., & A.W. (2006). Eyes on the Solar System [Computer software & mobile app]. NASA - ComponentAce. https://eyes.nasa.gov/eyes-on-the-solar-system.html

Accelerated Learning Inc. (n.d.). STEMscopes Curriculum. STEMscopes - The Leader in STEM Education. Retrieved September 22, 2020, from https://login.acceleratelearning.com/