# How do the Earth, Moon and Sun move within our Solar System?

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## Introduction and Rationale:

Astronomy has been a major part of science education for decades. Students often learn about the Solar System and Earth's location within the galaxy. In recent history, the understanding of the Earth and its' place in the solar system has changed. Many teachers, as well as students often revert to the memorization of planets and reciting facts about space. Very few people can actually explain how the Earth fits in to the universe and how the Sun and Moon fit within our lives on the Earth.

No longer can astronomy be taught on the concept that Earth is the "third rock from the Sun". Students need to understand the movement of the Earth, Sun and Moon within our solar system in order for them to truly conceptualize concepts of how our the relationship between the location, size and movement of all three structures enables the Earth to continue to maintain its unique atmosphere. In addition, the idea of how all of this movement causes changes in days and nights, Moon phases and seasons on Earth. Many students carry the misconception that the Sun is the center of our universe. Not only is this heliocentric (Earth) approach to astronomy incorrect, it often leads to more confusion to students as they move to higher grades.

Astronomy is an area of science where new information is constantly being collected, information is being changed, and details are being adjusted. With the advancements in both technology and our understanding of space, it is vital that students understand the motion of the Sun, Earth and Moon within our solar system.

## School Profile and Course Specifics

Louis L. Redding is a Middle School that houses grades 6,7 and 8 in the Appoquinimink School District in Middletown, Delaware. It is one of three middle schools currently in a rapidly growing district. The enrollment of students is approximately 900. The school district is mostly based in a rural community, but has seen tremendous growth over the past few years. There are plans to build three new schools (including a new middle school) in the next few years to alleviate classroom overcrowding. The district plans to expand even further after that building to accommodate for the tremendous growth.

The Appoquinimink School district has made a movement in the last few years to meet the Next Generation Science Standards (NGSS) and adopted and inquiry based science curriculum in the Middle Schools. Students will learn science through project/problem based learning. Students will run investigations, collaborate with peers, and research different aspects of phenomena to create their own explanation. Across the district students are focusing on formulating and writing scientific explanations of such phenomena in the form of a writing response called a CER. CER is an acronym used for writing the scientific responses across the state that includes students writing a (C)claim to answer a question, supported with fact based (E)evidence and (R)reasoning based on science knowledge and inquiry. The CER response will have a scientifically based claim, be backed by factual evidence and supported with scientific reasoning. As a sixth grade teacher within the district, most of my students are just beginning the process of inquiry based learning. They have not had much experience with project based learning within the science content. Therefore, content vocabulary and collaborative structures usually have to be supported by the teacher in the instruction.

The unit I am writing will be taught at the sixth grade level in a middle school classroom. The class will be an inclusion classroom consisting of students who are labeled as Special Education students as well as students who are academically gifted. The class will be co-taught and the average class size will be around 32 students. The students heterogeneously mixed in science and social studies class based on abilities. I am writing this unit as a supplemental unit for our sixth grade curriculum. It is considered an “add on” unit to address the common understanding of the Earth, Moon and Sun relationships. This unit will be taught using LFS strategies focusing on essential questions. In addition, it will address the NGSS standards of: 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. The unit will also address the Science and Engineering practices of developing and using models and analyzing and interpreting data.

Through my research, I have found that one of the hardest concepts for Middle Grades students to understand when dealing with space is the relative size, location and movement of the Earth, Moon and Sun. Many people have a misconceived understanding of this relationship based on the childhood belief of the Sun and Moon are rotating around the Earth at the exact same time every day. Students tend to believe that the Sun sets at the exact same time the Moon rises. Another common misconception is that the Moon has a light and dark side which is why it is not always full. Learning a new subject such as astronomy in a constructivist way may encourage students to rethink the accuracy of their alternative conceptions, they need further personal experiences to correctly apply concepts of astronomy. This unit will develop a curriculum that will both actively engage my students and address the needs of my instruction based on the NGSS standards.

**Learning Objectives**

Completion of this unit will result in students answering the big question: How do Earth, Moon and Sun move through space? Students will need to understand the rotation of the Earth around the Sun and the Moon around the Earth by interactively applying models and simulations to answer the big question. They will also need to develop a general understanding of the locations of all three in order to successfully answer the question.

The big question will be explored in small intervals addressing the smaller Lesson Essential Questions: How does the Earth move in a day, month and year? Why does the Moon look different every night? How does the Sun affect the Moon? Can you describe the Earth, Moon and Sun's relationship in a normal day in Delaware?

Students will start by understanding the location of the Earth in regards to the Sun and Moon. Students will have to identify how the Earth moves in a day and year. Following this concept students will explore the location of the Moon in regards to Earth and the Sun. They will explore how the Moon moves around the Earth and how the Sun affects the visibility of the Moon. They will explain these movements and how they create patterns in days, months and years.

In the end of the unit, I would like the students to complete a culminating scientific writing response to the big question in the format of a CER (Claim, Evidence and Reasoning). The response to the question: How do the Earth, Moon and Sun move within our Solar System? This will be answered addressing rotation, location, and size of each. Students will explain the movement using concepts from class exploration. Lessons will include technology in the instruction, as my school is a 1 to 1 Ipad school, models and simulations, as well as inquiry based activities. The evidence and reasoning within their writing based on class research, models and activities rather than a "googled" answer. For this reason, many of the in class activities that will lead them to understand the movement and cycles within our solar system will be based on visual demonstrations, interactive websites, and creation of a simulation using given materials to show the scale and movement of the Earth, Moon and Sun.

**Content Objectives:**

Prior Learning

At this point in my course, students will have studied the following topics: Geological changes in the Earth and Forces and Motion. Geological changes covers information from surveying and monitoring changing topography of Earth's surface due to tectonic plate movement to inferring the location of plate boundaries based on understanding the convection within the Earth's mantle. The forces unit will have covered topics from push/pull and propulsion force to diagramming and understanding balance and unbalanced forces and how they affect movement. There will be a heavy focus on the concept of gravity during the forces unit and its relationship to objects in motion. Although students have general knowledge on scientific inquiry, for many it will be their first in depth experience learning about astronomy concepts past the idea of day and night. All students know general information about the Earth, Moon and Sun, but in middle school very few can accurately explain the relationship and motion of all three.

The students will have very little background knowledge of astronomy prior to this unit. We will build on their ideas of Earth being in constant motion and changing and gravity to further understand Earth's place within our solar system.

With the completion of this unit students will be able to develop and use a model of the Earth-Sun-Moon systems to describe the cyclic patterns of lunar phases. They will complete this aspect by creating a model of the Moon phases. Within their model, my students will be able to describe the location of the Sun in regards to the phase of the Moon. Students will also be able to investigate the motion of the Earth and its relationship to the motion of the Sun and Moon. Students will be able to describe how the Earth rotates on an axis and orbits around the Sun. They will use these concepts to show how a 24 hour period would take place. They will also understand that the Moon is a satellite of both the Earth and the Sun. However, the force of gravity of the Sun on the Moon and the force of gravity of the Earth on the Moon affects the speed at which it orbits each. The amount of the Moon visible is dependent on the location of the Sun at that time in which the Moon is visible. Through research, the use of models and simulations students will evaluate and communication science information by writing a response to the question: How do the Earth, Sun and Moon move?

**Key Content**

Sun

The Sun is the largest object in our solar system. It is about 2/3 away from the actual center of Milky Way Galaxy. However, the Sun does not remain motionless in the middle of the Solar System. The heliocentric belief of the solar system is a very common misconception. Contrary to popular belief, scientists do recognize that the Sun is moving throughout the Milky Way Galaxy very slowly. At the Same time the Sun is moving, the Earth is moving around the Sun and the Moon is orbiting around the Earth.

In comparison to other stars, the Sun is considered just average in size. It is actually characterized as a yellow dwarf star. The Sun is the only object in our solar system that produces its own light. All other objects in the Solar System including the Earth and Moon reflect the Sun's light, however, the Earth and Moon reflect much more from our viewpoint. The distance from the Sun to the Earth is about 400 times the distance from the Earth to the Moon.[1] The Sun is about 695,508 kilometers from Earth. The approximate distance from the Earth to the Sun is a unit of measurement called an astronomical unit (AU). It takes the light from the Sun eight minutes to travel that distance to the Earth.[2] It is a star that only looks different to us on Earth due to how close it is to us. At over 1.4 million kilometers in diameter, the Sun contains 99.9% of the mass of the entire solar system: well over a million Earths could fit inside its bulk.[3] Scientists estimate that the Sun is roughly the age of the Earth-about 4.7 billion years old. They believe it will continue to burn for another 7 billion years.[4]

Like most stars, the Sun is composed mostly of Hydrogen and Helium. The Sun is extremely dense. In fact, the density of the Sun's core is eight times the density of gold.[5] The Sun shines as a result of thermonuclear fusion reactions in its core, and the energy produced by these reactions heats the gas in the Sun's interior sufficiently to prevent the weight of its own matter from crushing it. This energy is, also, the source of heat and life on the Earth, and small variations in the Sun's energy output, or even in the features present in its atmosphere, may be sufficient to profoundly affect terrestrial climate. [6] The temperature in the Sun core is about 15,000,000 degrees Celsius, whereas the surface is a cool 5,700degrees. The Sun does have its' own atmosphere composed of superheated gases. This atmosphere is only visible during the time of an eclipse in which so much of the Sun's brightness is blocked. The viewable atmosphere is called the Sun's corona. When it is visible, it appears as a glowing ball around the Sun.[7]

The Sun's energy release is not constant. The surface of the Sun has traveling dark spots and clouds of hot plasma causing explosions. The Sunspots or dark spots on the surface do rotate which has helped scientists to understand that the Sun is rotating on an axis. These Sunspots are the location of changing magnetic fields on the surface of the Sun. The magnetic fields move in a convection current across the surface of the Sun.[8] The Sun is not sitting stationary in the universe. It actually rotates around the center of the Milky Way Galaxy.[9] Because the Sun is so large in comparison to the planets in our solar system, other objects are pulled toward the Sun and rotate around it. The Sun's rotation around the Milky Way is much slower than the Earth's rotation.

From Earth, the Sun seems to rise in the East and set in the West. The time in which the Sun's light is present from your location on Earth is daylight time. Roughly twelve hours later the Sun will set in the West and the person will experience a time of darkness or night time. During this time in which a person experience a full light and darkness, the Earth will rotate one full time on its axis. This takes roughly 24 hours to complete.

The reason the Earth is able to rotate around the Sun is because the Sun exerts a "pull" or force on the Earth to keep it rotating around the Sun in a nearly circular pattern.[10]

Earth

The Earth is roughly 4.6 billion years old. It has a diameter of 7,926 miles.[11]It is revolving around the Sun. It is located about 92,956,522.4 miles from the Sun.[12] The Earth's surface is about three times more reflective than the Moon making it much brighter than the Moon to the human eye during observations when viewing Earth from space.[13]

Due to its location in relation to the Sun, the Earth is the only planet in the solar system known to have life. About 71% of the Earth is covered in water which is essential for life to exist. If the Earth was located closer to the Sun all of the water would have evaporated and the atmosphere would not have been able to support life.[14] If the Earth were located at a farther distance from the Sun, the climate would have been too cold to support life.

The Earth is made up of three distinct layers. The inner and outer core is made primarily of iron and nickel. Both of these layers are very dense. The mantle is the thickest layer of Earth. It acts as both a liquid and solid. The material in the mantle heats up near the core. One the material is heated it becomes less dense causing it to move up to the surface of the Earth. As it moves away from the heat source of the core, the mantle material starts to cool and solidifies becoming denser. The more dense material then moves back down toward the core and the whole cycle happens again. This process is known as convection. Above the mantle is the crust. The crust is the outermost layer of Earth. There is continental crust and oceanic crust. The continental crust is thicker than the oceanic crust. All the crust is broken in to segments called tectonic plates. Tectonic plates are constantly in motion due to the convection taking place in the mantle. Therefore, crust is always being created and destroyed.

Although the Earth is constantly changing, it continues its elliptical orbit around the Sun due to a gravitational pull. Sir Isaac Newton's law of gravitational pull is used to describe how the Earth stays in orbit around the Sun, as well as, how the Moon orbits around the Earth (and the Sun).[15]

In ancient times, astronomers made a model in which all objects in space revolved around Earth (as this was based on fact at the time). This geocentric idea of the universe was accepted until Copernicus introduced the heliocentric method with the belief that all objects around the Sun. Although this was closer to the truth, it was proven to be incorrect when it was noticed that planets, including Earth did not orbit in a perfect circle. The Earth orbits around the Sun in the form of an ellipse or an oval. All planets orbit in an elliptical pattern with two foci guiding that orbit. Some planets orbit is much more oblong than others. An ellipse is not a complete circle, but for the Earth, it is close to a circular shape than a lot of other planets. This idea was solidified mathematically with Kepler's Laws of Planetary motion.[16] The Earth takes roughly one year for the Earth to completely move around the Sun.

The Earth orbits around the Sun at a tilt or axis of about 23.5degrees. This angle is measured between the plane of orbit around the sun and the rotation axis of the Earth. The movement of Earth on its axis as it rotates around the Sun results in the seasons we experience on Earth. When our location on Earth is tilted towards the Sun we will experience warmer climates (summer) in comparison to when we are located on the area tilted the farthest from the Sun. It takes the Earth approximately 365.26 days to revolve around the Sun.[17]

While the Earth is slowly moving around the Sun (approximately one years' time), it is also spinning around its axis or center. One full rotation of the Earth on its axis is considered a day to most scientifically. During this rotation of the Earth on its axis we will experience about twelve hours of day and 12 hours of night with the Sun rising in the East and setting in the West. The actual amount of daylight and Sunlight will vary based on our location on the globe.

Moon

The Moon is roughly 4.6 billion years old, the same age as Earth. It is Earth's only natural satellite. Due to the closeness of the Moon to the Earth, the gravity on Earth is able to pull the Moon enough to cause it to rotate around the Earth as well as the Sun. When we look at the Moon we can see only about 7% of the Sun's light that is reflected from it.[18] The Moon absorbs much of the light from the Sun. (Kolodner 2010) It is rocky body that orbits the Earth at an average distance of 238,000 mi (382,942 km). Its diameter is about one-fourth Earth's diameter or of about 2,160 miles. .[19] Gravity is the force between two objects. When applying this idea of gravity to something on the surface of the Moon to something on the surface of the Earth; the Earth's pull of gravity is much greater. The mass of the Moon is only about one-eightieth (1/80th) the mass of Earth, so the force of gravity is smaller. On the Moon, the acceleration due to gravity is only one-sixth that of Earth's gravity. Accordingly, masses weigh one-sixth as much on the Moon when compared to weights on Earth. [20] The Moon is covered with rocks, boulders, craters, and a layer of charcoal-colored soil from 5 to 20 feet (1.5 to 6 meters) deep. The soil consists of rock fragments, pulverized rock, and tiny pieces of glass. Two types of rock are found on the Moon: basalt, which is hardened lava; and breccia, which is soil and rock fragments that have melted together.[21]

For the first several million years of the Moons existence, the surface of the Moon was struck by many meteorites resulting cracks and craters on the surface of the Moon. The surface of the Moon is made mostly of igneous or volcanic rocks which came from the core of the Moon when those cracks were formed by meteorites. Larger craters on the Moon are believed to be due to impacts force rather than volcanic activity. Due to the intense heat of many of the meteor strikes to the Moon's surface the crust of the Moon melted then later dried making dark craters. The dark spots on the Moon are the areas in which the crust has melted and dried in these craters. There have been small amounts of sedimentary rocks found on the Moon which scientists believe is caused by falling debris from meteor impact in space. The Moon has no overall magnetic field. According to the currently favored model of planetary magnetic fields (the dynamo model), this means either that the Moon probably has no molten core or that only a very small part of the core is molten. [22]

Moon Phases

The Moon orbits Earth approximately once per month, causing the pattern of Moon phases. Just like the Earth, the Moon also spins on an axis. The tilt of the Moon on its orbit is roughly five degrees six seconds.[23] The Moon takes about the same amount of time to spin once on its axis as it does to revolve around the Earth.  Therefore, we always see the same side of the Moon.   Although half of the Moon's surface is always illuminated by the Sun and half is always shaded, the portion of the illuminated surface that we see changes as the Moon orbits Earth.  We refer to the visible face of the Moon as the Moon phases.  These changes are caused by the changing of angles between the location of the Earth Moon and Sun.  It takes about 29.5 days for the Moon to go through the entire cycle and then begins again.

Observations of the Moon from Earth reveal different phases of the Moon with respect to the percentage of lunar surface reflecting Sunlight back to Earth. As the Moon orbits Earth, it comes nearly between Earth and the Sun once a month at the time of a new Moon, and orbits Earth in very nearly the same plane that Earth orbits the Sun. If the Moon's orbital plane had zero tilt off Earth's orbital plane, a total lunar eclipse would be visible every month.

There is actually about a 20° tilt, so total eclipses over selected area occur only about seven times a year, when Earth is directly between the Sun and the Moon. Earth's shadow falls on the full Moon, and it slowly becomes dark and then bright again as it moves out of Earth's shadow.[24]

The Moon's first phase is called the New Moon.  The New Moon is when the Moon is directly between the Earth and the Sun.  Therefore, the side of the Moon that is illuminated is not viewable from Earth.  During this time, many astronomers like to observe the sky because there is no additional light interfering with the vew of the sky. [25] One day after new Moon, a faint sliver can be seen low on the western horizon at Sunset. The phase has moved from new to a waxing crescent. As the Moon continues in its counterclockwise orbit, the crescent grows larger, or waxes. One week later, the Moon reaches its second primary phase, first quarter. Accordingly, the Moon has moved one quarter of the way around Earth.[26] At the first quarter Moon, the Sun, Earth and Moon form a right triangle with their positioning in the sky.  During this time, the Moon can actually be seen during daylight hours.  For the next couple days after the quarter Moon, the amount of the Moon visible gets larger, but it is not quite half of the Moon.  This is called a waxing gibbous.

When the Sun, Earth and Moon form a straight line again with the Earth between the Sun and Moon, the whole Moon will be illuminated.  This is called a full Moon.  To the visible eye, during a full Moon the Sun and Moon are on opposite sides of the Earth. After the full Moon, the Moon starts to get less visible again.

When the angle between the Sun, Earth and Moon begins to get smaller again. The first part of the Moons phases repeat but in reverse order. The Moon's phase is also getting smaller. It's moving from waning gibbous to its third- or last-quarter phase. A third- quarter Moon sits at 3 o'clock on the phase dial, where the Sun-Earth-Moon angle is once again 90degree angle. From Earth, we see half of the Moon's disk illuminated - the side opposite as the one illuminated at first quarter. A third-quarter Moon rises about six hours after the Sun sets, reaches its highest point in the southern sky at dawn, and sets at about noon. In the week after third quarter, the Moon moves through its waning crescent phase and eventually returns to new where the cycle begins again.[27] (see figure 1)

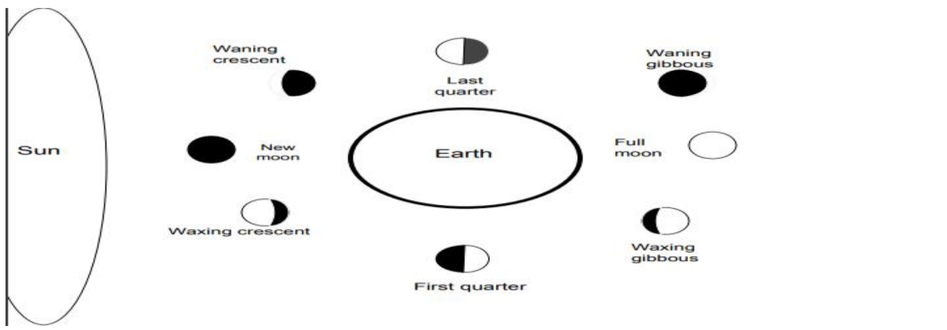


*Figure 1:The Moon Phases based on the location of the Sun*

There are special types of Moons you may hear of when watching the news or listening to weather predictions. The Moon may be referred to as a super Moon when it is a full Moon at its closest distance to the Earth and a supermini-Moon when at its farthest distance from Earth, regardless of the Moon phase (see figure 3). The Moon has a farthest and closest distance to Earth due to the Moon's elliptically shaped orbit.(see figure 2) The super Moon often looks very larger and brighter based on its location in relation to the location you are viewing from Earth. Whereas, a super mini Moon will look smaller for the same reason.

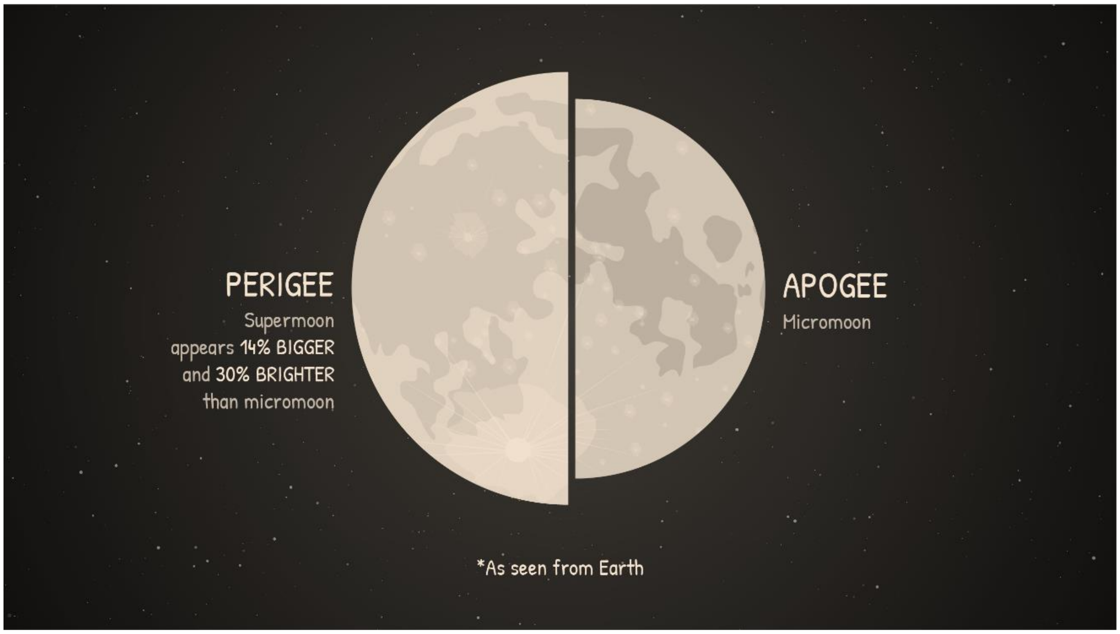


*Figure 2: The two halves illustrate the difference in the apparent size and brightness of the moon during a supermoon. The left half shows the apparent size of supermoon at perigee, while the right half shows the apparent size of a micromoon full moon at apogee.*[28]

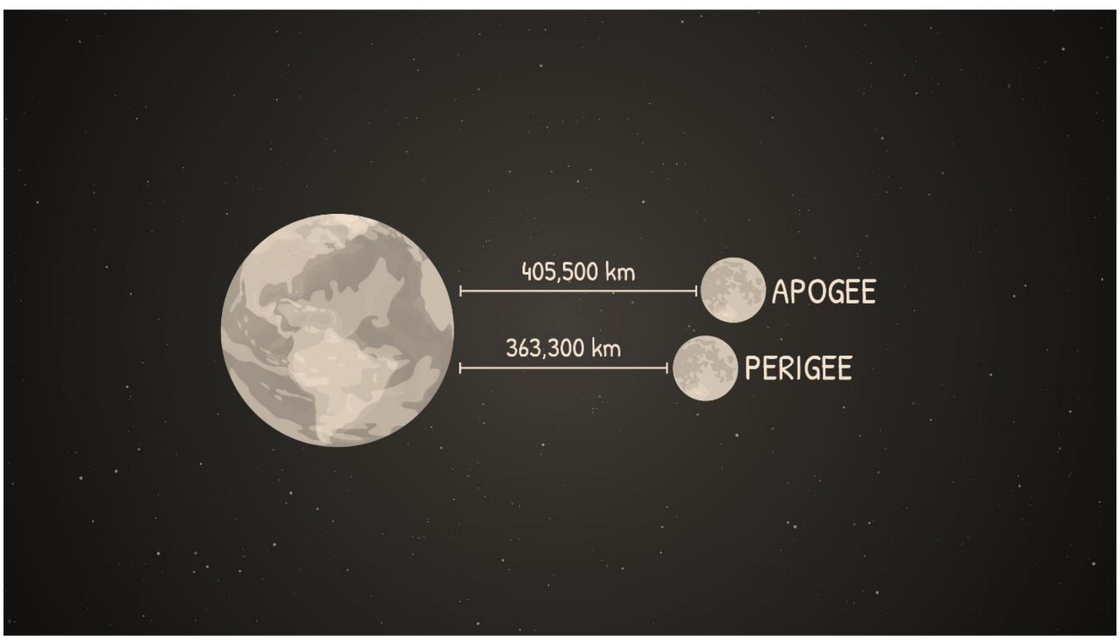


*Figure 3: This figure shows the slight change in distance from the Earth for a supermoon and a micromoon.*[29]

A blue Moon is something that rarely happens. A Blue Moon in astronomy refers to the second full Moon in a month and is not really blue. This usually occurs in months with 31 days, when a full Moon rises at the beginning of the month and another one rises at the end of the 29.5-day lunar cycle. A blue Moon has also been defined as the fourth full Moon occurring during a calendar year. Usually, there are three full Moons in each of the four seasons, which are three months long. About every three years, however, one of the seasons will have a fourth full Moon.[30]

Eclipses

Eclipses can occur any time the Sun, the Moon, and Earth are all positioned in a straight line. This does not happen often because the plane of Earth's orbit around the Sun is different from that of the plane of the Moon's orbit around Earth, so the Moon is usually located just above or below the imaginary plane of Earth's orbit. The planes of Earth's orbit and the Moon's orbit coincide only twice a year, and actual eclipses occur only during a small percentage of these eclipse seasons[31].

There are two types of eclipses. A solar eclipse is when the Moon blocks our view from the Sun. A lunar eclipse is when the Moon moves in to the Earth's shadow so it is no longer visible. It is not visible because it is no longer reflecting the Sun's light. A solar eclipse occurs when the Moon blocks Sunlight that normally falls on Earth and can only occur at the time of New Moon. In most months the Sun-Moon-Earth alignment is not exact and the Moon's shadow misses the Earth because the plane of the Moon's orbit is tilted slightly to the ecliptic. If the alignment is correct, the Sun is eclipsed.[32] .

Both a total and partial eclipse can occur depending on the viewer's location on Earth. A partial eclipse is when only part of the object disappears from our line of vision. There can be a total eclipse in which one space object totally blocks the light from another space object. Many of you may remember the total eclipse of 2017 in which the Sun was totally eclipsed by the Moon in the middle of the day. There were certain areas which experiences a full eclipse, while others only saw a partial eclipse.

With the completion of this unit students will be able to: Develop and use a model of the Earth-Sun-Moon systems to describe the cyclic patterns of lunar phases, investigate the motion of the Earth and its relationship to the motion of the Sun and the motion of the Moon, and describe or create a model of the Moon phases. Finally, through research, the use of models and simulations students will evaluate and communication science information by writing a response to the question: How do the Earth, Sun and Moon move? In a CER (Claim, evidence and reasoning) format.

**Strategies**

Students will work within collaborative learning groups throughout the unit to create a cohesive model that will support the answer to the big question. The groups will be heterogeneously created and remain the same throughout the unit. As groups, students will communicate their understandings to their classmates after in class activities to try to identify valid fact and common misconceptions.

Learning Focused Lesson Planning

I will use the Learning Focused Strategies (LFS) format for instruction. LFS format will include the use of Unit Essential Question (UEQ) which will be further broken down in to smaller Lesson Essential Questions (LEQ's). The UEQ will be: How do the Earth, Moon and Sun move within our solar system? The LEQ's will include: How does the Earth move in a day, month, and year? Why does the Moon look different every night? How does the Sun affect the Moon? Can you describe the Earth, Moon and Sun's relationship in a normal day in Delaware?

Kagan Cooperative Learning

One common strategy that will be utilized within the collaborative learning groups is a Kagan Cooperative Learning strategy called Think, Pair, Share. This is a strategy I utilize commonly within my classroom. It allows students to reflect on their knowledge and with appropriate "think time" formulate an answer to an open ended question. Then, students will pair up with other students to share their ideas. By doing this it allows all students to have an opportunity to create their own answer, share ideas with students, as well as, allows students themselves to correct misconceptions with each other. I find this method so much better than cold calling or asking for answers in a direct instruction setting. Those methods often result in students feeling uncomfortable or the same students answer questions throughout the entire class.

Another Kagan Cooperative Learning Strategy I utilize often within my instruction is Think-Write-Round Robin. This method is very similar to the Think-Pair-Share strategy, but instead of just think time it also requires students to write and even draw responses to open ended questions. Again, students get time to think and formulate their answer in the form of words or a picture. The Round Robin aspect happens when they share within their cooperative learning groups. These groups range from three to six students typically within my class. Again, this allows students to discuss answers and correct misconceptions of those in their groups before the teacher looks for an answer.

Technology Integration

My school has a one to one ratio of iPads to students. Students will utilize technology throughout instruction to complete various learning activities. Students will be assigned utilize the Nearpod App for research. This app allows for students to read text, watch videos and answer questions in the form of surveys, short quizzes, open ended response answers and even drawings. Students will utilize Schoology on a daily basis to complete assignments. When recording responses for Kagan Strategies or observations, they will do so on their Google Drive. Finally, when presenting findings to the class students will collaborate on google slides to create visual presentations. They will then airplay these presentations to the Smart Board when discussing their findings with the class. The use of Google Drive allows students to collaborate with each other without having wait time as one person does the work. In addition, as the teacher, I can assign these tasks through Schoology and monitor the progress of each individual student as they work from my Google Drive.

**Activities**

Mapping the Sun

LEQ's: How does the Sun move throughout a day? Year?

Anticipatory Set: Students need to understand the path of the Sun throughout a day in their lives. I will utilize the simulation of a full day cycle on the website Stellarium.com (sped up 10,000x the normal rate). I will show the students this simulation on the SmartBoard using my desktop as the control so all students are seeing the same thing. After students watch I will have them utilize a Kagan Strategy of Think, Pair, Share to discuss the following questions: What were some changes you noticed as you watched the 24 hour period? How did the sky look different throughout? I will them have them watch a few more days (sped up 100,000x the normal rate) Did you notice any specific patterns as you watched? What direction were things moving? What was moving?

After the discussion I would ask students to explain how the visible Sun changes throughout a day from their location on Earth (Middletown, DE)?

Inquiry Activity

After the initial discussion we will continue to explore the movement of the Sun through our visible sky throughout a 24 hour period. Students will take a piece of blank paper and draw a horizon line across the middle of it (this line can be pre-drawn if needed). They will then draw a stick figure to represent themselves in the middle of the horizon line. It may be beneficial for students to draw a compass rose on the paper to ensure they know the appropriate directions of North, East, West, and South. I will then start the Stelliarium simulation on the SmartBoard at midnight. I will progress through the day hour by hour. At each hour, I will stop and ask students where the Sun is located? If they cannot see it I will ask why. At the first time the Sun is visible on the horizon, I will have the students draw the Sun on their paper in a location similar to that and to label the time. On this first sight of the Sun, I will have them label Sun rise (in the East) I will continue move the simulation hour by hour and having students draw and label the location on their paper.

This drawing will progress through the time the sun set (in the West) and back to 12:00 AM of the next day. When the Sun is no longer visible, I will have students Think-Pair-Share with their groups to predict where the Sun is actually located at this time. We will then share these predictions as a class and come up with a class consensus. Once they have realized that the Sun is no longer visible because it is located below the horizon, we will draw it on our paper as well and label the time. It would be beneficial at this time to have this diagram on the board as well.

Assessment

After completing the activity I will have the students write a written response to the lesson essential question: How does the Sun move throughout a day? Year? Explain. I will use their responses to guide areas needed to reteach or extend upon if needed.

**The Movement of Earth**

LEQ's: How and why does the earth move? How is the sun related to the movement of the earth?

Anticipatory Set: I will start this lesson by writing the definition for rotate on the Smartboard. Rotate is to spin around. After that I will either demonstrate rotating by spinning around or having students do it to show the class one rotation. A counterclockwise rotation will then be demonstrated by the teacher or modeled by students. I will emphasize that this is the direction that the earth actually rotates on its axis, from west to east. I will follow up with this by asking students: What would happen if the earth stopped rotating? Students can Think, Pair, Share this question. We will then discuss ideas as a class and ensure that students understand that one side of the earth would have constant sunlight and the other half would have no sunlight at all.

Next we will discuss how the earth rotates on its axis every day. This movement creates night and day for us. The part of the earth facing the sun experiences daylight. During that same time, the other part of the earth experiences night time because there is no sun. However, the earth does not rotate with its axis vertically. The earth's axis is actually tilted 23 degrees. We will then think, pair share the question: What would happen if the earth did not tilt? The answer we would discuss to reach would be that we would not have different seasons and the day would be exactly twelve hours at all times and everywhere on Earth. I will then take a small styrofoam ball and insert two toothpicks in the top and bottom of it to represent the earth's axis. A 23 degrees tilt is almost 1/3 of a 90 degrees angle. We will then light a lamp without a shade in the middle of the room to represent the Sun.The teacher will tilt the styrofoam ball and demonstrate counterclockwise rotation of the earth with a tilt of 23 degrees. Note that the tilt remains the same as it rotates on its axis and revolves.

Following this, I will write the definition of revolve on the Smartboard. Revolve is to move around another object. The teacher will tie in the word orbit with the earth's revolution. The orbit for the earth's revolution is the path that it takes around the sun. The teacher should draw a yellow circle on an overhead and draw an elliptical path around the sun showing the earth's orbit. Then the teacher will demonstrate revolving by walking around the "sun" or lamp. Note that the earth revolves also in a counterclockwise direction too. A complete demonstration of the earth rotating on its axis and revolving around the sun will be done by holding the Styrofoam ball, tilting it 23 degrees, rotating it counterclockwise while walking in a counterclockwise direction around the student holding the sun. I will ask the following question: How many times does the earth rotate on its axis to complete one revolution of the sun? Hopefully, one of the students will answer 365 times which creates one year for us.

Modeling

After students have discussed and viewed the class demo I will place a light bulb in the middle of each table to use as the sun (camping lanterns will be used here). Groups will insert the toothpicks into the top and bottom of the Styrofoam ball. This will indicate the earth's axis. Next, they will draw an imaginary line around the center of the Styrofoam ball to indicate the equator. In addition, they can mark a spot on the Northern Hemisphere to indicate Delaware for part of the simulation. I will give each group time to practice tilting the Styrofoam ball 23 degrees to show the earth's tilt. Then I will have students take turns rotating the earth (with the tilt) as indicated on the handout in a counterclockwise direction. After that they, will revolve the Earth around the Sun in a counterclockwise direction focusing on the fact that this is a model of the sun and earth and how their movements are connected to each other. While students are simulating the Earth's movement I will guide them with the following tasks (this could be done in the form of a checklist or one at a time with class discussion in between): Show the Earth's movement in one day? Model how day/night time would happen in the marked location. How would Earth move in six months? A year? Extension: Where would the Earth be during winter, spring, summer, fall in regards to its location around the Sun.

Assessment

Students will answer the following questions after modeling the rotation and revolution. They will then respond to the following prompt in written format: How does the Earth's rotation AND revolution affect your life? The students will need to explain in their response how the rotation of the Earth causes day and night to take place and the revolution around the Sun takes a year which causes seasons to take place.

**Moon Phases**

LEQ's: Why does the Moon look different every night? How does the Sun affect the Moon? This lesson is intended to have students' correct common misconception and understand the phases of the Moon. Students will interactively model the phases of the Moon. After modeling the phases, they will then apply their understanding to follow up comprehension and application based activities.

Anticipatory Set: In order to have students start thinking about how and why the visible part of the Moon changes I will first have them do a pre-assessment task of drawing a prediction of what the Moon will look like for the next two weeks. Ideally, I would start this on a day of a new or full Moon, but it could be implemented when appropriate for your lesson planning. In some phases, the moon can be visible during the day time. The Full Moon would be a good starting point because it rises at sunset which would be convenient for students with night schedules. The New Moon is also convenient as we can see a crescent near the sun at sunset after a few days. Following the prediction, I would have them observe the Moon for the two weeks prior to the activity to view the Moon nightly or early in the morning depending on the time of year and time of New Moon. I will have them record the location and visible part of the Moon as well as the location of the Sun and what they see in a Google doc. I will have students share this document with a partner in the event that one student is not able view at the required time. By utilizing the Google doc, I will be able to view their observations prior to teaching. In addition, if any student is unable to complete the task, I can have others share their document electronically in order for all students to have access to general observations.

At the end of the observation period I will have the students in their collaborative learning groups discuss the following questions using the think-pair-share strategy: What parts of your predictions were right? Describe what you had wrong about your predictions. Are there any patterns you have noticed about the visible Moon during your recordings? Why do you think the Moon looks different every night? How does the Sun affect what you see in the night sky?

Inquiry Activity and Modeling

Each group of students within my classroom will be given a stick with a styrofoam ball attached to it. In the middle of the groups table, I will place a light bulb or lamp with no shade. This light source will become the Sun. To make this as effective as possible, all other classroom lights will need to be turned off and shades will need to be pulled. Students had to stand in front of the light and stretch their right arm holding the 'Moon' towards the 'Sun'. Then they had to move counterclockwise and watch how the illuminated part of the 'Moon' changed shape. After completing a whole turn they had to draw the successive phases of the Moon, to compare them with their predictions, and to answer several questions related to the activity, including their causal explanations of the Moon phases.[33]

After performing the simulation of the Moon phases as seen from the Earth, the students will use the Think-Write-Round Robin Strategy to answer the following questions: Were your original predictions correct? Why or why not? How will we see the Moon two days after the First Quarter? How will we see the Moon ten days after the First Quarter? What is the angle between the Sun and the Moon in the First Quarter?

Direct Instruction

Students will complete a class led Nearpod on the Phases of the Moon. As we go through the Nearpod students will participate in questions checking for their understanding. I will explain to my students that a "New Moon" is when the Sun is only illuminating the part of the Moon we do not see, so it is dark. As the Moon orbits around the Earth, the angle between the Earth-Moon-and Sun changes causing us to see different areas where the Sun's light is reflected. This cycle happens monthly. I will remind them that the Moon orbits the Earth in a counter clock-wise direction. I will teach my students that half of the Moon is always lit by the Sun, but the amount of the "lit" part that we see changes.

We will discuss that the term waxing means that the lighted side of the Moon we see from Earth is growing. When this happens the light is on the right side of the Moon. The term waning is when the light side of the Moon we see from Earth is getting smaller. This happens when the light is on the left side of the Moon. We will discuss that the Moon is considered a "crescent" when less than half of it is illuminated. When all or half of the Moon is illuminated it is a quarter Moon (a full Moon and a new Moon are part of this). When the Moon is more than half lit, but not 100% it is a gibbous. Crescent, half and gibbous Moons will be waxing or waning depending on the side of the Moon that is illuminated based on the location of the Sun.

Assessment

I will close this activity by assessing the students with the attached worksheet titled Phases of the Moon. This worksheet will assess if students can identify how the position of the Earth-Moon-Sun affects the visible Moon in the sky. They will also have to identify what type of Moon it is based on its position in relation to the Earth and Sun. I will also assess their written response to the open ended question-In your opinion, what causes the phases of the Moon. I will use these results to gauge student understanding of the concept of Moon movement and phases.

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**Appendix**

**Appendix A**

MS ESS1-1 Develop and use a model of the Earth-Sun-Moon systems to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon
Students will need to understand the rotation of the Earth around the Sun and the Moon around the Earth by interactively applying models and simulations to answer the big question. They will also need to develop a general understanding of the locations of all three in order to successfully answer the Unit Essential Question.

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