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An Alien Earth, Far, Far Away!

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Introduction

What do you see when you look up in the sky at night? Billions upon billions of shining objects vastly spread across the sky. Astronomers used to believe that Earth was the center of our solar system until other astronomers debunked that theory and proved that the sun is the center of our solar system. But with the advancement of technology and modern physics, the solar system is more expansive and more mysterious than we know. We have also learned that Earth may not be the only solid object in the solar system that is habitable. A few planets have some criteria of possible life forms or habitability the planet and even a few moons. During the unit, students will have the opportunity to learn the order of the solar system, explore the physical compositions of planets, and learn how astronomers detect and calculate the distance between celestial objects. Students will also have the opportunity to what an exoplanet is and how they are categorized.

Demographics

This unit is intended for 5th -grade students at Cleveland Elementary School and 5th -grade teachers utilizing Next Generation Science Standards. Cleveland Elementary lies in the heart of the Shaw/Howard District of Washington D.C. Cleveland has a dual language/immersion program. We served students from pre-K3-5th grade. Cleveland is a Title 1 school that provides free or reduced lunch to 99% of the students. The total enrollment for Cleveland fluctuates between 290 and 315 students. Many of the students are African American (55%) Hispanic/Latino (29%), White/ Non-Hispanic (9%), and less than 7% represented by Asian and Native American students. My school believes in the holistic approach when educating a child. We offer art, music, science, library, and physical education for every child throughout the school year. Cleveland Elementary is a part of Cluster V in DCPS.

Rationale

My reason for creating this unit is that the science standards and content background have become stagnant. Teachers are not receiving updates on discoveries, and teachers are, therefore, left with executing the same unit every year or left with the absence of pedagogy for the content. The standards I was taught about our solar system as a child seem to resemble the same standards for our 21st -century learners. As astronomers find learn new information about the solar system teachers should be privy to that information. Teachers must

be provided this content so that we can spark the curiosity of our students and plant the seed for the next generation of astronomers and scientists. For the longest time, my peers and I believed that the reach of our solar system stopped at Pluto when it was considered a planet. I want to expose my students to a solar system that expands beyond our reach and a galaxy that expands even beyond and introduce scientific vocabulary. As humans, we get self-absorbed thinking the world revolves around us. But we are insignificant in comparison to the thousands of galaxies in the universe. I want my students to know that there are planets different from our own that can harbor life. I want my students to expand their knowledge when it comes to space and broaden their perspective as an adult, I did not think that was possible. Students are always curious about space because it is a subject that we know little about. With science fiction being a popular genre in movies, students wonder about aliens, doppelgangers, and if there are possibilities to live on another planet.

Content Objectives

- Learn about the composition of the terrestrial planets and the gas giants.
- Understand and explain the definition of an exoplanet
- Learn about the relative distance between Earth and planets in our solar system

Content Background

Students will gain an understanding of our Earth, the other terrestrial planets, the gas giants (Jovian planets, i.e., Jupiter-like planets), and learn the definition of an exoplanet. Our galaxy is called the Milky Way, although scientists just call it the galaxy. It is named that because of its milky appearance as it spreads across the sky. The Sun is the center of the solar system, and it is surrounded by eight planets. All eight planets revolve around the sun. The planets in our solar system are in order of their distance from the Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. A mnemonic device that can be used to help students remember the order of the planets is “My Very Eager Mother Just Served Us Nachos” or students can create their mnemonic to make it more personalized. The planets (with the exception of Uranus and Neptune) are observable in the night sky because they are not very distant from the earth, and because of their nearness, they appear larger than a star, their motion around the sun also makes them move with respect to stars (the word “planet” comes from the Greek word for wanderer). A common unit of distance in space is to describe it in terms of how long it will take light (which has a speed of 186000 miles per second) to travel. Thus, the sun is a little more than eight light minutes from Earth. The planets can be divided into two categories: The terrestrial planets or rocky planets are Mercury, Venus, Earth, and Mars, and the gas giants are Jupiter, Saturn, Uranus, and Neptune. Students will also learn the definitions of dwarf planets as well as exoplanets.

Types of Planets

Terrestrial planets are Earth-like planets made of rocks or metals with a hard surface. Terrestrial planets possess heavy metal cores, some have moons, and topological features such as valleys, volcanoes, and craters. Terrestrial planets, even though smaller in mass are denser than the gas giants. The gas giants are Jupiter, Saturn, Uranus, and Neptune. The gas giants are also known as Jovian planets, meaning Jupiter-like in

composition. Our solar-system gas giants are known to have many moons A gas giant is a large planet of relatively low density and consisting predominantly of hydrogen and helium. Some gas giants are failed stars. A failed star is a celestial body made of gas that cannot sustain nuclear fusion of hydrogen because it could not reach the necessary mass for it during its formation like a successful star. Gas giant exoplanets can be much larger than Jupiter, and much closer to their stars than anything found in our solar system. For most of human history, our understanding of how planets form and evolve was based on the eight planets and Pluto in our solar system.

Mercury

Mercury is the closest planet to the Sun, and it is about the same size as the Earth's moon. Mercury's distance from the sun is 36 million miles. It also shares similar composition as the moon. It has a very thin lithosphere (rocky layer) and a larger solid metal core. The planet's density is the second highest in the solar system only slightly less than that of Earth.[1] Since Mercury is the closest planet to our sun, its orbital period around the sun is only 88 days. Since it revolves so fast around the sun, it is named after the Roman God Mercury, who was known for his swift feet. Mercury is extremely hot during the day, reaching temperatures of 750 to 800 degrees Fahrenheit. Since it does not have an atmosphere at night, temperatures can drop to -330 degrees Fahrenheit.

Venus

Venus is known as the sister planet to Earth. The reason being they are similar in size and almost identical in density. However, Venus is extremely hot because it has been subject to a runaway effect because of the gases in its thick atmosphere. The phenomenon, called the "runaway greenhouse" effect, occurs when a planet absorbs more energy from the sun than it can radiate back to space because the heat is blocked by gases in its atmosphere.[2] Under these conditions, the hotter the surface temperature gets, the faster it warms up. 96% of Venus's atmosphere is Carbon Dioxide, so a lot of the sun's heat is maintained on Venus's surface. Venus also possesses clouds with a mixture of sulfuric acid and sulfuric dioxide. The temperature on Venus is 730 K (Over 850 F), entirely too hot to sustain any form of life, as we know it. Venus has experienced volcanic activities. In January 2020, astronomers reported evidence that suggests that Venus is currently volcanically active, specifically the detection of olivine, a volcanic product that would weather quickly on the planet's surface.[3] About 75% of Venus's surface is considered to have low-level lava plains. Venus does not have plate tectonic activity, so there is no evidence of subduction zones (when two plates come together, and one slides underneath the other). The orbital period of Venus is 225 days. Strangely enough, Venus rotates in a direction opposite of the direction of its revolution around the sun.

Earth

Earth is known as the blue marble of our solar system. Earth is our only example of a planet that is habitable and inhabited. Only slightly larger than Venus, Earth is the largest of the four planets closest to the sun. 71% of the Earth is covered in water, while the remaining 29% consists of continents and islands. Earth's atmospheres consist of mostly nitrogen and oxygen which are essential for life on the planet. Earth is the third planet from the sun and has been around for about 4.5 billion years. The plane on which the Earth orbits the Sun is known as the ecliptic plane. Almost all other planets revolve around the sun on the ecliptic plane. Earth takes 365.25 days for its orbital period. This number is the basis of our normal 365-day-year and 366-day leap year.[4] As Earth orbits its sun, it also rotates counterclockwise around its axis through its North and South pole that is tilted about 23.5 degrees concerning a line perpendicular to the ecliptic.[5] It is the densest planet in our

solar system. Earth has one moon, the Moon, that orbits the planet. Almost all materials on Earth are constantly being recycled.[6] The three most comm are the carbon cycle, rock cycle, and water cycle.[7] The earth is composed of four different layers. The layers from the outside are the crust, mantle, outer core, and inner core. The crust which is the thinnest layer is made mostly of rock and soil. The crust is only 3.1 miles deep. Next is the mantle, which is the thickest layer of the Earth at 1,802 miles deep. The mantle is made up of slow-moving molten rock (or magma). The heat from the mantle causes the tectonic plates to move. The shifting of the plates can result in mountains, volcanoes, earthquakes, etc. The lava that spews out volcanoes is from the mantle. The outer core is made of liquid iron and metal. The outer core is 1,367 miles thick. It is very hot reaching temperatures up to 8,132 degrees Fahrenheit. Lastly, is the inner core since the inner core has such a great amount of pressure, the liquid iron, and nickel form into a solid. The inner core is at about 9,392 degrees Fahrenheit. That is the same temperature as the surface of the sun. The inner core is 746 miles in radius.

Mars

Mars is known as the red planet, for its composition is mostly iron that has been oxidized over time. Named after the Roman God of war. Mars' atmosphere is like that of Venus because it is mostly Carbon Dioxide, however, its atmosphere is much, much, thinner in comparison. Mars is more interesting because it is more hospitable. Mars is an excellent place to search for new life because it is the planet most similar to Earth in the solar system. Mars has carbon dioxide, nitrogen, oxygen, and organic compounds. The only issue is Mars's thin atmosphere. There is so little air on Mars that, once the sun begins warming the surface and driving hotter air upward, the entire planet's atmosphere readjusts, sending pressure waves from one side of the globe to the other.[8] It was suggested that Mars was once full of water, warmer, and had a thicker atmosphere, offering the potential for a habitable environment. Mars is presently recognized as paleo-habitable given its previous habitability. Even from Earth, we can observe the polar caps changing throughout their seasons. The frozen cap on Mars is not frozen water but frozen Carbon dioxide (dry ice). Mars' surface remains cold with temperatures 82 degrees below zero. Mars being the terrestrial planet furthest away from the sun takes 687 days to complete its orbital period.

Jupiter

Jupiter is the nearest gas giant and the largest planet in our solar system. Jupiter is approximately 484 million miles away from the sun. About five times as far as the Sun is to Earth. It takes Jupiter 12 earth years to orbit the sun, but Jupiter rotates on its axis extremely fast. It takes Jupiter 10 hours to complete a full rotation, giving Jupiter the shortest day in our solar system. Jupiter's atmosphere is consisting of approximately 90% Hydrogen and 10% Helium gases. It has a colorful surface, and it is covered with enormous storms. It is famously known for its giant red spot. This spot is a gigantic vortex that has been swirling for centuries. Jupiter's winds can exceed speed up to 432 km/h (268 mph). Presently, Jupiter has 59 named moons, but 79 have been identified. Even with Jupiter being a planet of storms its average temperature is -238 Fahrenheit. With so many moons, Jupiter possesses rings. Unlike Saturn's rings which are made of ice, Jupiter's rings are very faint and are made of dust.

Saturn

Saturn is the second largest planet in our solar system and even though it's not the only planet without rings, its rings are the most prominent. Saturn has been known since ancient times because it can be seen without advanced telescopes. Since it is so far away from the sun, Saturn's rings are made up of chunks of rocks,

covered with ice and dust. Since Saturn is a gas giant its atmospheric composition is made of hydrogen and helium. Since it is composed of these light gases, it is the least dense planet in the solar system, so light can float on water. The length of the day is a little bit over ten hours. It is approximately 891 million miles away from the sun and its orbital period is 29 years. Saturn's winds are very strong. Its winds blow eastwards in the same direction as it rotates. The winds can generate speeds up to 1100 km/h (683 mph). Therefore, Saturn appears to have bands circumflecting the planet.

Uranus

Uranus is the 7th planet from the sun. Uranus is 1.83 billion miles away from the sun. Even though it is not the furthest planet away from the sun, it has the coldest atmosphere in the solar system. The reason being, because billions of years ago something big crashed into Uranus with so much force that it tipped the planet on its side. Uranus still orbits around the sun today on its side. The impact of the collision also let some of the heat that was trapped inside the planet escape. Uranus maintains a temperature of -224 degrees Celsius (-435 degrees Fahrenheit) and its atmosphere contains more water and ice than Saturn and Jupiter. Like the other gas giants, its atmosphere contains mostly Helium and Hydrogen. However, Uranus has higher concentrated levels of methane, specifically in its upper atmosphere. The level of methane creates more absorption of red light from the sun resulting in its blue color. Uranus also possesses four major rings and has a total of 17 satellites. One day on Uranus takes up to 17 hours. Uranus's orbital period (one Uranian year) is 84 Earth years.

Neptune

Neptune, the ice giant is the 8th and the most distant major planet orbiting our sun. Most of its mass is a hot dense fluid of icy materials, water methane, and ammonia, above a small rocky core. Neptune's name comes from the Roman God of the Sea and its 14 moons are named after sea gods and nymphs in Greek mythology. Neptune possesses rings, although very faint. The rings are clumps of dust and debris formed by nearby moons. It is approximately 2.78 billion miles away from the sun giving its orbital period of 164.81 Earth years. Neptune is made up of helium and hydrogen. The methane provides it blue composition like Uranus, but since it has a higher concentration of methane the blue looks stronger on Neptune. The winds on Neptune are extremely strong. With winds speeds up to 2,100 km/h (1,300 mph).

The Dwarf Planets

Three criteria need to be met to be classified as a planet. First, it must be in orbit around the sun. Second, it has a hydrostatic equilibrium (A nearly round shape). Lastly, it has "cleared the neighborhood" around its orbit. You may be wondering what "clearing the neighborhood" entails. This means with the help of its gravity; Pluto should be able to clear asteroids and dwarf planets out of their way during its orbit. So, it meets the first and second criteria but not the third. Therefore, it is not a planet. So, what happened to Pluto? In 2006, Pluto was re-classified from a planet to a dwarf planet. Pluto's distance from the sun is approximately 3.7 billion miles away and lies in the Kuiper Belt. That is 39 times the distance between the sun and the Earth. Its' size is relatively small, being about 1/5 of Earth's diameter and only about two-thirds as wide as Earth's moon. With Pluto being so far away from the sun it takes the dwarf planet 248 years to complete its orbital period. Pluto has one of the coldest places in the solar system with temperatures dropping 387 degrees below zero (-232° Celsius). Pluto has five moons with Charon being the closest moon and Hydra the most distant. While nitrogen and methane ice cover much of the surface of Pluto, these materials are not strong enough to support enormous peaks, so scientists suspect that the mountains are formed on a bedrock of water ice. Another fact

about Pluto is that it's an ice dwarf but is positioned past the gas giants in our solar system making it an outlier. Pluto also has a special orbital plane. The eight planets orbit around the sun all lie within the same plane. But Pluto's orbital plane at an angle lies 17° with respect to the ecliptic plane, as shown in the image below.

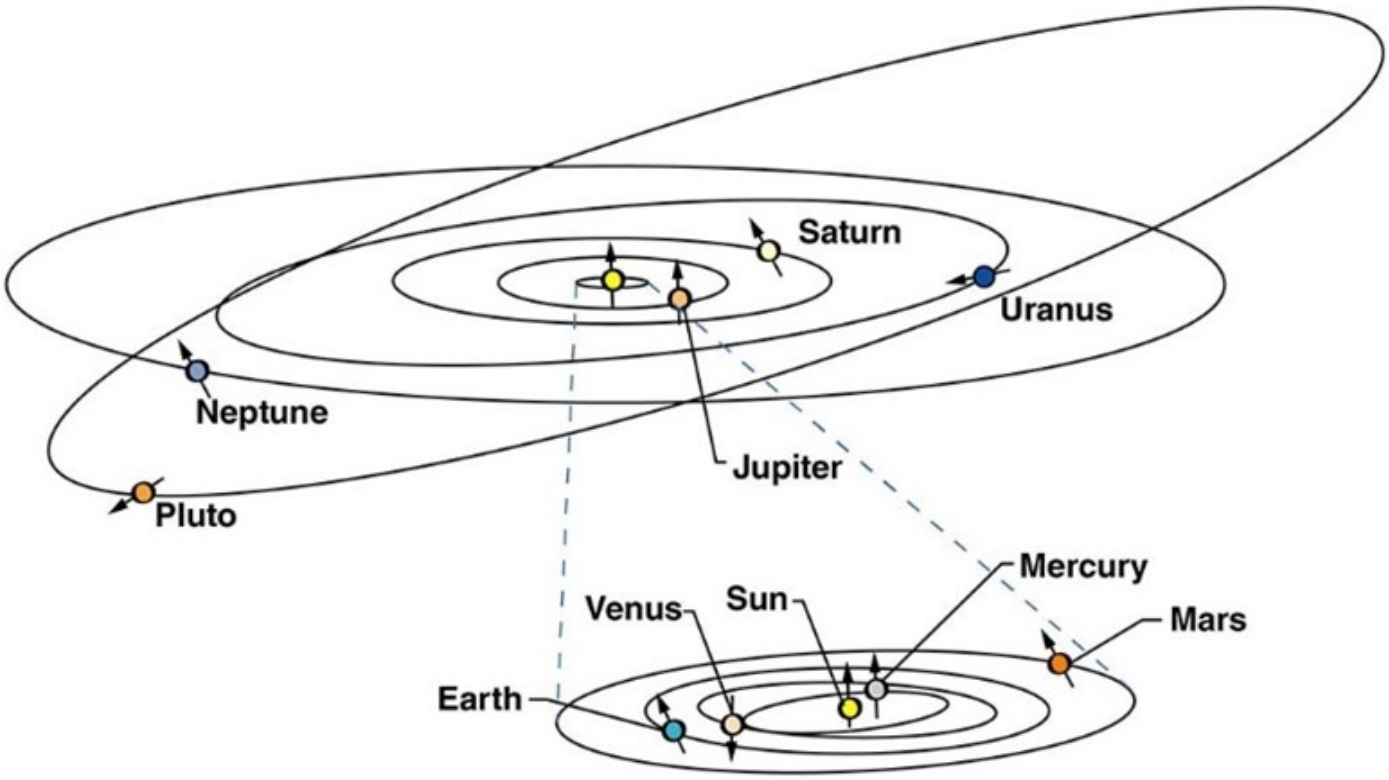

Figure 1: This image shows the orbital path of Pluto, Credit: NASA

Ceres is the largest object in the asteroid belt between Mars and Jupiter. It is the only dwarf planet located in our inner solar system.[9] Ceres is also the first dwarf planet to have a spacecraft on its surface. Ceres was called an asteroid for many years. Because Ceres is so much bigger and has a rockier surface than its surrounding neighbors, and is spherical it was classified as a dwarf planet in 2006. The same year Pluto was re-classified as a dwarf planet. Ceres' orbital period is 1,682 Earth days and one rotation around its axis is nine hours. There is no evidence of an atmosphere on Ceres. However, there are sporadic signs of water vapor, possibly from ice ejected by small impacts. Eris is another dwarf planet; it is a little bit smaller than Pluto but three times farther away from the sun. Eris was discovered on January 5th, 2005. Eris is about 1/5 the size of the Earth. If the Earth was a nickel, Eris would be a popcorn kernel. Eris is approximately 6.2 billion miles away from the sun, which gives Eris a distance of 69 AU. It takes sunlight more than nine hours to get to the surface of Eris. Eris takes 557 Earth years to do a full revolution around the sun. It takes Ceres 25.9 hours for a full rotation, making the day length similar to Earth's. Unlike Ceres, which has no moon, Eris has a very small moon that orbits the planet called Dysnomia. Dysnomia is essential to determine how Eris is compared to Pluto. Other dwarf planets have been discovered but information is still being gathered on most of them.

The Sun

The sun is the star that lies in the center of our solar system (hints at the name). It provides the light and heat energy that helps sustain life here on Earth. Its gravity is responsible for keeping all the solar-system

bodies orbiting around it. It is a giant ball of plasma that the hydrogen and helium fuse together and creates a process called nuclear fusion, taking place in its core. Nuclear fusion is when one proton smashes into another proton so hard that they stick together and releases energy.[10] As the heat is being generated in the core, it is transported outwards and finally leaves the surface and radiates out into space. Our sun is middle-aged, having been born about 4.6 billion years now. Nothing can live on the sun, but its energy is vital to life on Earth. The sun is the closest star in our solar system but is not the largest in the Galaxy. The sun appears the largest because it is so close, but observations and evidence have proven that there are stars much larger and brighter than our stars. The sun is a yellow dwarf star, which is relatively small to other stars in our universe. Its temperature can reach 5,778K which equates to 9,940 degrees Fahrenheit. Measuring a day on the sun is complicated because it rotates differently. The sun is made up of super-hot plasma and the sun rotates at different speeds at different parts of the solar latitude. At its equator, the sun rotates in 27 Earth days. At its pole, the sun rotates on its every 36 Earth days.[11] A lot of activity happens on the sun's surface. The atmosphere of the sun can be divided into three layers, the photosphere, chromosphere, and the huge corona. The atmosphere of the sun can be divided into three layers The photosphere is the lowest level of the sun's atmosphere. The term photosphere means "sphere of light and is the layer where most of the sun's energy is emitted. The photosphere is marked by bright, bubbling granules of plasma and dark cooler spots, which emerge when the sun's magnetic field breaks through the surface.[12] The dark spots are the source of solar flares. A solar flare is an eruption of electromagnetic radiation from the sun's atmosphere. The chromosphere is the layer above the photosphere. Its name comes from the Greek root (meaning color). This layer is red because heated hydrogen emits in red light. But the red rim can only be seen during a solar eclipse. The chromosphere extends about 1,200 miles above the visible part of the sun's surface. The last layer above the sun's surface is the corona (meaning crown). Like the chromosphere, the sun's corona can only be seen during a solar eclipse. Temperatures in the corona can get as high as 3.5 million degrees Fahrenheit.

The Goldilocks' Zone

The goldilocks zone or habitable zone is when a planet is in a position in its solar system where water can remain a liquid. With the presence of liquid, there is life, or the possibility of life inhabiting a planet. An example of a planet in the goldilocks zone is our Earth. It is far enough from the sun that the water doesn't boil away but close enough that the water doesn't freeze. Mercury Is inhabitable because it is too close to the sun. Venus lies in the habitable zone, but its atmosphere is composed of high concentrations of greenhouse gases causing the surface to be entirely too hot for any water to exist. If you look at the images below, Earth lies within the inner boundary of the conservative zone. Mars is also in the habitable zone, but it has a thin atmosphere, which makes it vulnerable to other solid objects. Earth which orbits between the two has a surface "just right" for water to remain in liquid form. Robotic space missions found evidence of ancient lakes and minerals that could have only formed in water.

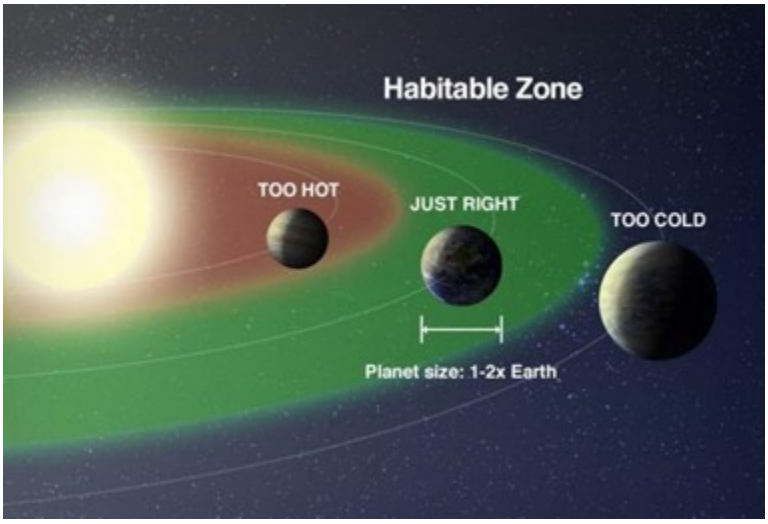

Figure 2: Illustrates the “Goldilocks Zone” and planet Earth lies “just right” in the habitable zone. Credit: NASA

Habitability and Life

Scientists and researchers have discovered that Earth may not be the only planet that possesses the qualities of habitability. When we speak of planets that may be habitable, we are going off of what we already know, which is the Earth. Here on Earth, we have water, an atmosphere that is susceptible to living things on earth, and energy from the sun. However, who is to say that other planets do not have forms of life on their planet based on that planet’s qualities? It is highly unlikely that we find a planet that is identical to Earth and its characteristics. So, life on another planet would probably not look anything similar to life here on Earth. Even so, that planet can be habitable if it possesses a few things. Habitability is a key concept for astrobiologists, who think of it intuitively: the ability of a planet to be inhabited by life[13] . For a planet to be considered habitable, it must possess water in liquid form. Based on my seminar, life must be able to do three things; metabolize, reproduce, and evolve. A lot of science fiction displays aliens to look a lot like humans. However, that is unlikely since they aren’t many planets that we know are in that “Goldilocks zone” to show signs of life similar to that of Earth. The detection and discoveries of exoplanets have been one of the most exciting phenomena in recent years. Now they are several dozen possible candidates for habitable planets. The next paragraph will explain the definition of an exoplanet.

What are Exoplanets?

An exoplanet is a planet that orbits another star and is, therefore, outside our solar system. The first sign of possible evidence of an exoplanet was in 1917 but was not fully recognized. A planet revolving around a dead star was detected in 1992, however, the first planet around a normal star was discovered in 1995. There are four exoplanet types Terrestrial, Super-Earth, Neptune-Like, and Gas Giants. Terrestrial planets are Earth-size or smaller, mostly made of rock and metal. Some could possess oceans or atmospheres and perhaps other signs of habitability, Super-Earths, are typically rocky and more massive than Earth but lighter than Neptune. They may or might not have atmospheres. Neptune-Like planets are, similar in size to Neptune and Uranus, with hydrogen or helium-dominated atmospheres. Lastly, gas giants, which are the size of Saturn or Jupiter, or much larger. They include “hot Jupiters” scorching planets in close orbits around their stars. Exoplanets are extremely hard to see directly with telescopes. They are hidden by the bright glare of the stars they orbitso; astronomers use indirect methods to detect and study these planets. They search for exoplanets by looking at the effect these planets have on the stars they orbit.[14] One way to search for an exoplanet is to look for a

“wobbly” star. A star that has planets doesn’t orbit perfectly around its center.[15] From far away this off-center orbit makes it look like it is wobbling. Over the last 25 years, there have been more than 5,000 exoplanets discovered.

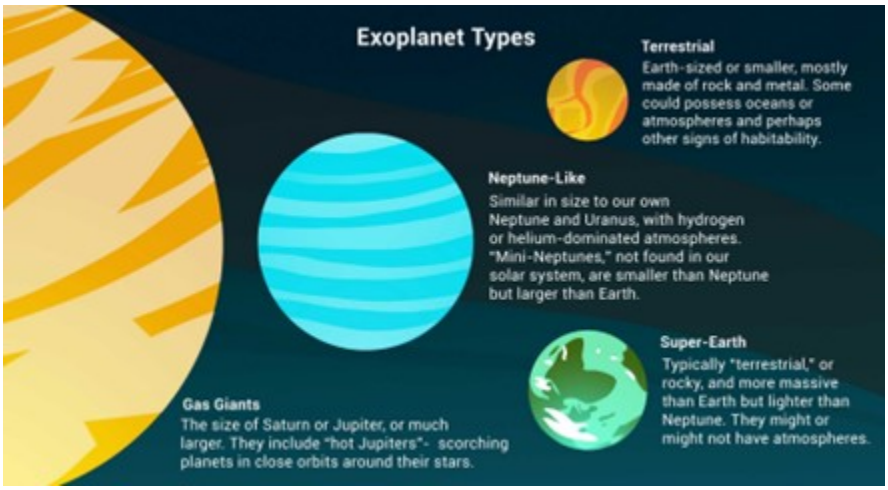

Figure 3: Nasa illustration of the four different types of exoplanets.

Moons

Commonly known as satellites, moons are astronomical bodies that orbit a planet, a dwarf planet, or a smaller solar system body. There are over 200 moons in our solar system. All the planets except for Mercury and Venus have a moon. Even Pluto and some other dwarf planets have a moon. Jupiter and Saturn have the most moons in our solar system. The theory on how Earth got its moon is called, the giant impact theory. Astronomers theorized that a rocky body about the size of Mars collided with the Earth. The debris from the collision floated into space and with gravity, it formed into the moon and remain in the earth’s orbit. Moons come in different shapes, sizes, and surfaces. There has been the discovery of a few moons containing the atmosphere and even hidden oceans beneath their surface. Most planetary moons probably formed from the discs of gas and dust circulating planets in the solar system, though some are “captured” objects that formed and fell into the orbit of a larger world.

Europa and Titan

Europa is the smallest of Jupiter’s four moons and slightly smaller than Earth’s moon. Europa is made mostly of silicate rock and a water-ice crust. What makes Europa so special is it has the smoothest surface of any known solid object in the solar system. The youth and smoothness of the surface have led to hypotheses of a water ocean below the frozen surface, which could harbor extraterrestrial life.[16] As Europa orbits Jupiter, the planet’s massive gravity creates tides on Europa, just as our moon creates tides on our ocean, and the friction of that pushing and pulling generates enough heat to keep the water liquid form. Titan is Saturn’s largest moon and the second largest satellite in the solar system. Titan was the first known moon to be discovered around Saturn. Titan is a special in that it is the only moon known to have a dense atmosphere. Titan’s atmosphere, the only moon in this solar system, is composed mostly of Nitrogen, but also 5% methane. It is also the only known object besides Earth to home stable bodies of surface liquid. The discovery was made in 1944 by an astronomer named Gerard Kuiper. He witnessed passing light reflected from titan through a spectrometer (an instrument that records and measures light) and detecting methane.[17]

Figure 4: Comparing the size and amount of liquid water on Earth and Europa. Credit: NASA

The planet's distance from the Sun

Planet	Distance from the Sun/miles	Astronomical Unit	Light Travel Time
Mercury	36 million	0.39	3.2 minutes
Venus	67.2 million	0.72	6 minutes
Earth	93 million	1	8.3 minutes
Mars	141.6 million	1.52	12.6 minutes
Jupiter	483.6 million	5.20	43.2 minutes
Saturn	1,427 million	9.53	79.3 minutes
Uranus	1,784 million	19.8	159.6 minutes
Neptune	2,794 million	30	4.1 hours

Table 1: The distances of planets from the Sun

Calculating the distance

Calculating the distance between stars and planets can be complicated. However, astronomers use a simple unit called Astronomical Units, also referred to as AU. The AU is the average distance between the Sun and the Earth, which equates to 1 AU. The closer a planet is to the sun the lower the distance in AU, and the farther away the larger the number in AUs. Uranus, which is approximately 917 million miles away from the sun has an AU of 19.2. Therefore, it is 19 times the distance from the sun as the Earth.

Strategies

Computer Simulation

Students will use computers to research the composition and atmosphere of the terrestrial planets and the gas giants. Students will explore a 3-D model of the planets in the solar system. While researching students will record details and facts about the planet, and produce questions, and deductions.

Collaborative Groups

Students will work together in groups of three or four students to complete group assignments. Students will complete their research as a group, collecting as many facts as possible and details about their planet. During the research period, students will have specific roles to ensure student engagement. Students will collaborate when constructing their presentation boards on their respective planets and present their board and information to their peers. Students will also work in groups to complete their scale model of the solar system, modeling the distance between the planets and the Sun.

Modeling

The teacher will model how computers will be used during research and exploration. Teachers may have to model how to give a proper presentation. Allow students to practice in front of you before the formal presentation. The teacher will also demonstrate how to create a scale model using basic materials. If you are giving specific roles to your students and it is their first time in that role, you may have to model the responsibilities for the students.

Kinesthetic Learning

Students will participate in gallery walks as they observe charts listing the characteristics and traits of the planets in the solar system. While students are reviewing, they can pose questions and write them on the chart to be discussed amongst the class.

Activities

Overview

For this unit, the teacher needs to transform their classroom into space. This will provide excitement and interest before the unit begins. The teacher can use stickers, posters, or hanging ornaments of the stars, planets, and moons to decorate their classroom. Students will explore the planets of the solar system, our Sun, and the moons in our galaxy with the use of collaborative learning and computer technology. Students will utilize their laptops to engage in a 3D model of the solar system bodies while constructing their questions and completing a scavenger hunt. While students are conducting their research, they will record facts about the planet and create a poster presentation about a specific planet. The students will create a scale model of the solar system and the distance between the planets and the sun. My students will use toilet paper, play-doh, markers, toothpicks glue, and tape. The students will use math calculations to create their scale key with

the use of toothpicks.

First, we will learn about the planets in the solar system and learn the order of the planets from the distance of the sun. Students will be introduced to a mnemonic, which will help students remember the order. The most utilized is “My Very Energetic Mother Just Served Us Nachos”. However, students will have the opportunity to create their own mnemonic. Students will engage in a planetary scavenger walk. Students will observe posters of the planet, Earth’s moon, and the Sun. Students will construct any questions they may have about the planet or write down any information they want to share. The class will have a group discussion about the questions and students will have the task of finding the answers to the questions, albeit rational questions. The students will explore a 3D model simulation of the planets and record specific facts about their assigned planet. With the use of their data collected, they will create a poster presentation of a planet and present it to the class. Students will outline the type of planet, its surface composition, its atmosphere, and any interesting facts they discover. Students will also learn about the distance from the sun for each planet. The culminating project will be the students creating a scale model of the planets according to the distance from the sun, while also using clay to create the planets of the solar system to scale.

Day 1: Students will watch a YouTube video introducing the planets in the solar system. Students will be introduced to a mnemonic to help them remember the order of the planets from the distance of the Sun.

Day 2: Students will create their own mnemonic device to help students remember the order of the planets. If students are having a challenging time creating their mnemonic device. Provide students with a template that they students will have to complete individually. Students will be given chart paper to decorate their mnemonic, so it can be posted around the school.

Day 3: Students will engage in a gallery walk, the gallery walk will display the planets, the sun, and the moon all in color. Students will migrate through the gallery walk, recording questions and/or observations of the solar system bodies. If students are having a difficult time generating questions during the gallery walk present the students with a simple fact sheet about each planet to stimulate curiosity. The teacher will highlight these questions for the next lesson.

Day 4: The class will have a share discussion of the questions posed during the gallery walk and observations made. The questions that can be answered will be assigned for groups to research and discover the answers based on their assigned planet.

Days 5-7: Students will be assigned into groups of 2-3 students per group. Each group will be given a planet to research information and try to answer the questions posed by the students during the gallery walk. Students will illustrate their planet and organize the facts on the chart. Students will practice their presentations before going in front of their peers.

Day 8: Students will present their planet poster to their peers and will attempt to answer any questions given by the students.

Day 9: Students will start their culminating project by creating the planet’s size to scale with the use of clay. Students will receive different items that scale to the size of each planet (for example, a ping pong ball will represent the size of the sun). Students will create the planets and the sun on this day.

Days 10-11: Students will begin to make their scale model of the distance between the plants and the sun. Students will be given the distance between each planet and the sun and with the use of the toothpicks the

students will have to calculate the number of toothpicks that will equate to the distance between each planet. The approximate scale to the distance will be given by the teacher.

Activity 1: Solar System Mnemonic Design

Students will observe a YouTube introducing them solar system and brief descriptions of each planet. The teacher will engage the students with a mnemonic device to help them remember the order of the planets by the distance from the sun. The most used is “My Very Energetic Mother Just Served Us Nachos”. This correlates with the order of the planets (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Students will attempt to create their own mnemonic to make it personalized and fun. If students are having a difficult time, the teacher can provide a template where the beginning and the end of the mnemonic are filled in and the students must complete the middle of the mnemonic. The students will use chart paper to display their mnemonic of the planets and students will present in front of the class.

Activity 2: Planetary Scavenger Walk

The eight planets of the solar system and the sun are going to be on chart paper posted throughout the classroom and the hallways. Each student will have a scavenger hunt checklist and the students will have to find the planet that matches the clue on the scavenger hunt. While completing the scavenger hunt, students must pose at least one question about each planet. These questions will be used for the research segment of the unit.

Activity 3: Planet Presentations

Students will be formed into groups of 2-3 students. Each group will be assigned a planet and they must find information about their planet. The students will also have to illustrate their planet. Students will be allowed to use the laptops and the websites given by the teacher to find information on their planet. The students will also have the responsibility to find the answers to the questions constructed by the students (albeit rational questions), during the scavenger hunt. Students will illustrate their planet and record the facts on a chart a paper. Students will present their planet to the whole class.

Activity 4: Solar System Scale Model

Students will be using clay, toothpicks, glue, and toilet paper to create their scale model (Size and distance). The teacher will give each group a list of everyday items that will represent the scale to the size of the solar system. The students will make the clay the size of the item that represents the planet. Students will use different colors of clay to resemble the hue of the planets. Once the models of the planets are created, the teacher will give the distance (in feet) between each planet and the Sun. The students will be given a toothpick and each toothpick will represent a specific amount of feet. The students will have to calculate the number of toothpicks needed to display the distance between the planets. The students will construct this model on a roll of toilet tissue.

Materials for Classroom Use

The following materials used for this unit are all suggested but not mandated. For students to create their own mnemonic students will need chart paper, colored pencils, and markers. Computers must be available for students to observe 3D simulations of the solar system. When creating their poster presentations students would need chart paper, markers, pencils, and glue. When students are calculating the distance between the sun and planets, students will use a calculator, pencils, and paper. For students to create their scale model of the solar system students would need toilet paper, toothpicks, clay, and glue. Students will have 1:1 laptops and will be collaborating in groups during projects.

Resources

https://www.solarsystemscope.com/

https://www.nasa.gov/astrobiology

https://www.youtube.com/watch?v=Vb2ZXRh74WU

https://www.youtube.com/watch?v=w36yxLgwUOc

Appendix on Implementing District Standards

NGSS Standard Integration- This unit will utilize the standards from Next Generation Science Standards with units “Interactions in Matter” and “Observing our Sky”. Instructing students about the matter will help them understand the three different states of matter that are present on earth and students will determine can

these states of the matter be found on other planets. If so, is there a possibility that extraterrestrial life can be found on exoplanets?

Disciplinary Core Ideas:

The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from earth. Students will discover this while we are discussing the distance between the planets and the sun.

Crosscutting Concept:

Natural objects exist from the very small to the immensely large. (5-ESS1-1)

Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)

Science and Engineering Practice:

Develop a model to describe phenomena

Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.

Support an argument with evidence, data, or a model

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Endnote

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