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Exploration: The Search for the Next Habitable Planet

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by Karen Y. Cameron

Introduction

Who has not wondered if life exists outside the confines of our solar system? I know that this question has plagued astronomers for many centuries as they tried to explain the complexities of the galaxy. Are there others? What is their life like? Are they green like the caricatures that we have seen on television and in the magazines? Are they waiting to attack us as soon as the opportunity arises? These are just a few of the questions that people have pondered for many ages. I know these questions to be true because I have wondered these questions myself.

As a Science Teacher, I have always been fascinated with the unknown mysteries that space presents. I have wondered if perhaps the rumor that the government is housing aliens in Area 51 is true, or whether it is just a myth that was created by Hollywood to sell movies. Who has not looked up into the sky and surmised that they just witnessed an Unidentified Flying Saucer (UFO) which was about to invade our solar system? I remember when I was a child growing up in the old neighborhood, we were playing out in the street one hot and sticky summer night and we witnessed something in close proximity about to land. Our first thought was that we were about to witness a UFO invasion. These are truly the beginnings of a really good sci-fi flick, "The Night the Aliens Landed". The street was very dark on this particular night and there was an ominous feeling in the air. We were all mystified as we waited to see what would happen next! As I look back on this memory, I feel as though we should have really proceeded home as fast as we could, but we did not. What we had just witnessed as it turned out was not an alien UFO but a dirigible, a Goodyear Blimp. This blimp had landed in the field directly behind our houses. I can certainly tell you that if we would have run home that night the story would have been much different than what I am describing right now. My memories as seen through my child eyes would have described it as the night we were invaded by aliens. The story could have been a bestseller!

District Demographics

I teach Middle School Science at Anna R. Langford Community Academy. This school is located in Chicago, Illinois on the south side of the city in a community named Englewood. Chicago has the 3rd largest school district in the country. This school has a small population of students. There are approximately 225 students in grades Pre-K- 8th grade. Langford School is a Title I school and qualifies for federally funded educational programs. Ninety-nine percent (99%) of our students live below the poverty level. These Title I funds are used to provide academic support to our students. The student population is composed of African American Students. The Englewood neighborhood is presently going through a gentrifying process which has increased our Hispanic population slightly. Our classroom average size is between 20-25 students which usually comprises more females than males. I share my class with another teacher who is there to assist our diverse learning students. Presently, in my class this coming year, there will only be 2 diverse learning students.

Rationale

This unit is going to enlighten some and indulge others in their wonder about the next habitable planet. Searching for the next habitable planet is an old question that has triggered conversations for many years. Children often ask their parents, “Are we there yet”? They are also intrigued with movies and comics on science fiction that fills their minds with wonder and mystery. Adults ask a slightly different question, “Are we alone in the universe or are there others”? This question has really taken off in the last few days since the release of the images taken by the James Webb Space Telescope. These images have caused everyone to revisit their thoughts of traveling to the far reaches of outer space in a spaceship. A new era of thought and of awe has just emerged. Students will be so enthralled with doing the investigation and research with the idea of finding a new planet which is suitable for habitation

We will be learning about the factors and resources needed to survive here on Earth. An Earth-like planet needs a star with similar characteristics to “our” star the Sun. There needs to be a water supply, the temperature must be suitable and comparable to our temperature here on Earth. We also need an atmosphere that will protect us from harmful Ultraviolet (UV) rays emitted from the sun. There needs to be a substantial supply of the following elements with Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen(N), and Phosphorus (P).

These objectives will lead and guide us on our journey to finding the Goldilocks planet that will satisfy the qualifications as stated above. Many extra-solar planets have been discovered in the last few decades which has sparked new generations of would-be explorers in trying to become the first to find what many others before them have tried to find. This unit will not only teach us about our home planet and Mars but help us to be more informed about those planets that may be waiting for discovery in the Galaxy.

Content Objectives

What is Life?

What is life? This is the question that has baffled scientists for many years. The next question is whether there is life outside of our solar system. Many scholars have wondered if it was possible for any other place to have the same accommodations that Earth has for us. Will the new planet be able to sustain life as we know it? The driving question remains the same, what is life? The NASA definition of life is "Life is a self-sustaining chemical system capable of Darwinian evolution".[1] For generations the definition of life has eluded scientists and philosophers. We can, however, list characteristics of the one example of life we know, life on Earth.[2] Life can be described as the ability to get and use energy, reproduce, grow, and respond to change. All living organisms share several key characteristics or functions: Response to Stimuli, Reproduction, Adaptation, Growth and Development, Homeostasis, Evolution, and Metabolism.[3]

Response to Stimuli

Response to Stimuli is organisms responding to cues given them by various stimuli in the environment. Humans for example will get chill bumps if they become cold. Eyes will blink if a foreign substance tries to enter into the eye. The body has numerous responses that are used to maintain a properly functioning body.

Reproduction

Reproduction is the process by which organisms through either asexual or sexual processes produce another organism with identical genetic material. Reproduction is a very important process that involves replication of genetic materials of organisms. Not all organisms reproduce the same way. Unicellular organisms reproduce by dividing into two new organisms. The new organisms will look the same as the original organism. Plants reproduce in two ways asexually and sexually. Asexual reproduction causes part of a plant to develop into a new plant. An example of plants that reproduces asexually are ferns and moss. Some multicellular organisms need a mate to reproduce. Humans are an example of a multicellular organism that needs a mate to reproduce.

Adaptation

Adaptation is the ability of organisms to adjust to the changes in their environment so that they will be able to survive. Animals for example can camouflage to keep predators away from them to avoid becoming the next meal for an animal. Survival is the key. Survival adaptations can include mimicry. This adaptation has the species resembling another more dangerous species to cause fear in a potential predator. These adaptations can be behavioral or physical. A behavioral adaptation is usually in response to an external stimulus which helps the animal to survive. An example of a behavioral adaptation is migration. Birds will fly to a warmer climate to avoid the cold weather. An example of a physical adaptation is camouflage. Animals can blend into the environment undetected to avoid being killed by a predator. An example of animal camouflage is a snow leopard.

Growth and Development

Growth and development are two characteristics which relate to all organisms. For a unicellular organism

growth involves becoming larger over time, or perhaps a change in shape. For simple multicellular organisms, growth would involve increasing the number of cells. However, highly complicated multicellular organisms will undergo a series of changes, usually referred to as their life cycle. Development in a multicellular organism, particularly animals, requires an egg to divide into another stage, an embryo. This embryo will form specialized cells in the body. The body will change over time and will continue to develop throughout the organism's life span. The time span of development will vary according to the organism. In plants, a new plant will form from seeds or spores or cuttings. It will form leaves and roots and then produce more seeds or spores, continuing the cycle.

Homeostasis

Homeostasis is any self-regulating process by which biological systems tend to maintain stability while adjusting to conditions that are optimal for survival. For example, sweat is a way the body regulates body temperature. If homeostasis is successful life continues, if unsuccessful, disaster or death ensues.

Evolution

Evolution is the change in the characteristics of a species over several generations that allows it to survive more successfully in its environment. This relies on the process of natural selection which says that organisms that have traits that make them successful will pass on those traits to their offspring, while organisms with unfavorable traits will die out. The process results in formation of a new species. Evolution relies on there being genetic variation in a population which affects the physical characteristics of an organism. Some of these characteristics may give the individual an advantage over another individual which they can pass to their offspring.

Metabolism

Metabolism is the ability to break down food into usable energy for the body. These chemical reactions help the body to grow and reproduce as well as respond to stimuli.

Cells and Living Organisms

Almost all life on Earth is made of cells. Cells are the most basic unit of life.

Unicellular Organisms

Unicellular organisms consist of just one cell. This organism uses this single cell to carry out all of life functions. A unicellular organism grows as the cell increases in size.

Multicellular Organisms

Multicellular organisms have many cells that are specialized to and have specialized functions to support the organism. Multicellular organisms grow as the number of their cells increase.

Now, as we look further into the question "What is Life," there are many hypotheses as to how life came to be. Many scientists feel as though the beginnings of life started with unicellular organisms. In the infamous

words of Jurassic Park consultant Dr. Ian Malcolm, “Life breaks free. Life expands to new territories. Painfully perhaps even dangerously, but life finds a way”. [4] The topic of life beginning on planets is ripe for discussion because scientists have found out that bacteria existed on Earth before any mammals resided here let alone humans. The Earth did not see any indication of life before the Holocene Period which is when signs of life were first detected. Life on Earth began about 3.5 to 4 billion years ago and the 1st life forms were single celled organisms similar to bacteria according to the Geologic Time Scale (See table 1 Below).

Table 1: The Timeline of 4.6 billion years of Planet Earth:

Period	Major Events
Hadean	Unicellular life appears
Archean	Photosynthesis begins
Proterzoic	1st eukaryotes, 1st multicellular life
Cambrian	The Cambrian Explosion
Ordovician	Molluscs and arthropods
Silurian	Land Plants
Devonian	Bony fish
Carboniferous	Coal Age swamps, amphibians, and insects
Permian	Reptiles
Triassic	Dinosaurs arrive
Jurassic	Dinosaurs dominate
Cretaceous	Dinosaur extinction
Paleocene	Early mammals
Exocene	Warm, wet climate, modern mammal families
Oligocene	Drying period, continents nearing current position
Miocene	Hominids appear
Pliocene	Cooling Period
Pleistocene	Major Ice Age
Holocene	Modern humans arrive

https://ucmp.berkeley.edu/education/explorations/tours/geotime/gtpage2c.html

Habitability

Habitability is the ability of a place to sustain life. Various factors play a role in habitability, such as light, temperature, energy, precipitation, etc. A habitable planet should be able to sustain life for a long time. We will use the Earth as our point of reference.

The next question has to be what is the habitable zone around a star? The habitable zone is an area around a star that has a temperature such that liquid water can exist. The area around the star where it is not too hot and not too cold for liquid water to exist on the surface of surrounding planets are other components of a habitable planet.[5] Most of the discovered exoplanets are orbiting a sun which is similar to Earth’s star, the Sun. There is an effort to find planets around red dwarf stars, since these stars live for tens of billions of

years. These stars are very common in our Galaxy.

Liquid Water

Liquid water is the first thing that is needed to sustain life as we know it. To be habitable an Earth-like planet would need to have water there to sustain life. Water is essential for many kinds of processes within living organisms. Water is needed for vegetation since it is needed to carry on photosynthesis, rainfall is also a part of the water cycle. Water can be found in various places on Earth. We can find water in lakes, ponds, oceans, rivers underground and various other places.

The Water Cycle

The water cycle is an important and continuous cycle which circulates water here on Earth. The cycle starts with precipitation in the forms of rain, sleet, hail or snow from the sky that can be circulated back to a new form through condensation, evaporation, transpiration, and run-off. Earth's water is always moving. The natural water cycle, also known as the hydrologic cycle, describes the continuous movement of water on, above, and below the surface of the Earth. Water is always changing states between liquid, vapor, and ice, with these processes happening in the blink of an eye and over millions of years.[6]

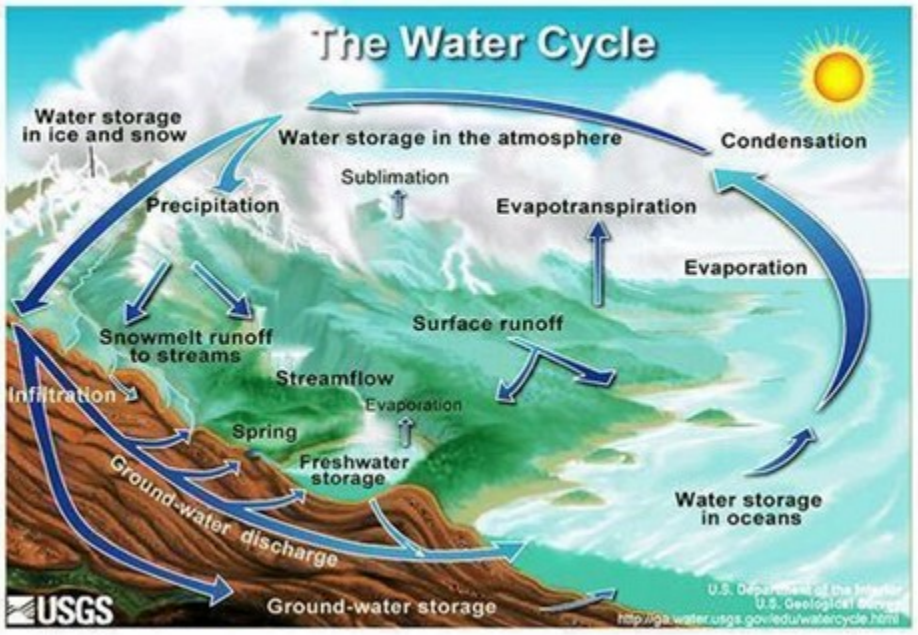

Figure 1: "Water Cycle" http://ga.water.usga.gov/eduwatercycle.html

Credit: U.S. Dept of Interior John Evans and Howard Perlman/ US Geological Survey

Temperature

Temperature plays a big role in habitability. Thus, the temperature on a planet will need to be suitable for life to exist.

Weather is the state of the atmosphere at a given time. We are familiar with hot and cold and wet and dry. A

hot temperature could be denoted as humid, scorching, or perhaps steamy. These words describe conditions, when the outside temperature is uncomfortably high for many people. Such conditions can occur in places that are close to the equator, in tropical areas during the summer. On the other hand, cold temperature conditions might be described as being frosty, freezing or perhaps even brutal. Such conditions are common at the poles or at high altitudes, but can be found in the winter months at other places too.

Wet and dry climates can be found in various parts of the world. Wet conditions are found in places that experience a lot of precipitation in the form of rain, storms, sleet, hail, etc. This type of weather can be found in places where there are tropical conditions, i.e., rain forests, but also in other parts of the world during the rainy season. Excessive amounts of precipitation can cause flooding in an area. Dry conditions occur in regions where there is a lack of moisture from any precipitation. This place could be facing a drought or it could be a desert where rainfall is naturally low. A drought happens because there has been a substantial loss of water in the area over a period of time which has caused vegetation and plants to turn brown or maybe even die.

Comparing Earth and Mars

Earth and Mars are both terrestrial planets, meaning they both are earth-like, i.e., they are rocky. These two planets will serve as baseline data for my students to use as a support in identifying what is needed for a planet to be considered habitable. Scientists use Earth all the time because it is the planet we live on. There are two theories about how these planets could have formed, the first is that they are formed by collisions among planetary embryos in the protoplanetary disk close to the sun, the second is that they formed by the accretion sunward-drifting small pebbles "pebbles" from the outer parts of the solar system. [7] Scientists use Earth as a reference because we have plenty of information to use. Our science curriculum starts off the beginning of the 7th grade school year having students explore the possibility of there being life on the planet Mars. We will start with our planet first and then delve into Mars' data.

Earth

The Earth is a good starting point because we are most familiar with our home planet. We know that Earth has the Sun as its star, which provides us with heat and light. The Earth has an atmosphere and it contains water. We are far enough away from the sun to not be burned by radiation. Being a terrestrial planet enables us to stand on our planet and to support vegetation which is needed to provide food for the inhabitants. The resources that we have are plentiful and provide us with the essentials to sustain life.

Mars

The planet Mars is also a terrestrial planet, however, it does not have the same qualities that Earth has. There is some evidence that Mars was once covered with water, and that there is water in the polar regions. There are many popular tales of life on Mars, but no life has been detected as yet.

Atmosphere

The atmosphere of a planet needs to be considered when discussing habitability. A planet's atmosphere may

have the right amount of essential gasses, or they may be deficient or excessive. We will take a look at these elements or gasses that can be found in the atmospheres of many planets, these are Hydrogen (H2), Oxygen (O2), Nitrogen (N2), Argon (Ar), Methane (CH4), Carbon Dioxide (CO2). Some planetary atmospheres, such that of Venus also have sulfur dioxide (SO2) and with clouds of sulfuric acid (H_2SO_4) others can contain ammonia.

Earth's Atmosphere

Let us start with our home planet Earth. Earth has a thick atmosphere that is composed of various amounts of different gasses, the most abundant ones being Nitrogen and Oxygen. There are also some trace elements in our atmosphere as well as dust and water vapor. The total mass of Earth's atmosphere is about $5x10^{18}$ The troposphere is the layer that is closest to Earth's surface. Temperature is also controlled by this part of the atmosphere. The troposphere is wetter than any of the other layers because it contains a lot of moisture.

The next layer is the stratosphere which is the layer that is directly above the troposphere. The stratosphere is vitally important because it serves as a shield from the ultraviolet rays of the sun. The stratosphere also provides us with warmth because of the presence of greenhouse gasses, if it were not for the greenhouse gasses the Earth would be cold. Directly above the stratosphere is the mesosphere which has a decrease in temperature as the altitude increases. This temperature profile is quite different from that of the stratosphere. Meteors and other space objects will burn up in this part of the atmosphere despite its thinness. As we go above the mesosphere, we will enter the thermosphere, a very hot part of the atmosphere where the temperature can reach an astounding 2000 degrees Fahrenheit. As you ascend further up, you will emerge into the last segment of the atmosphere, the exosphere, which has gasses escaping into the outer space realm. We have just taken a journey more than 10,000 km from the surface of the Earth directly to outer space.

The Earth's atmosphere has a high amount of nitrogen in it. Nitrogen comprises 78% of the atmosphere. Nitrogen in its natural state does not do anything in the atmosphere. Nitrogen has to be combined with other elements to become a nitrate. Nitrogen is a very necessary nutrient for humans because it is used by amino acids which are the building blocks of proteins.

Oxygen is the 2nd most abundant gas found in the atmosphere, at a breathtaking 21%. Oxygen is needed by all living organisms on Earth.

Carbon dioxide is also found in Earth's atmosphere approximately 0.04%. This gas is needed to warm the atmosphere. Without the warming effects of gases, the Earth's temperature will decrease drastically.

The next element is Argon, which makes up about 0.94% of Earth's atmosphere. Methane makes up a small percentage of volume in the atmosphere, 0.00017%. The methane gas helps the planet to stay warm and comfortable however, too much methane would contribute to global warming. The following elements and particles such as dust and water vapor are also in the atmosphere but the percentages are very small. (See Table 2 below)

Table 2-: Earth's Atmospheric Layers

Atmosphere Layers	Description
Exosphere	Outer Space, which is 6200 miles thick Spaceships and satellites are in this sphere.

Thermosphere	This layer is above the mesosphere and extends about 90 km to 500-100 km above our planet. X-ray and UV radiation from the sun is absorbed in this sphere. The aurora lights can be seen from this sphere.
Mesosphere	This layer lies directly above the stratosphere: it lies about 50 to 85 km above Earth. Temperatures decrease in this layer which is quite different in the stratosphere. The sky changes color from blue to black because of the lack of molecules. Rockets and meteorites can be found in this layer.
Stratosphere	Ozone can be found in this layer. It is vitally important because it absorbs ultraviolet radiation from the sun. Temperatures rise as you go higher in the stratosphere. Weather balloons and jet aircraft fly in this zone because of the thinnest of the air. The stratosphere is about 30 miles (km) above the troposphere.
Troposphere	Clouds are found in this layer and nearly all weather is found here as well. The troposphere extends to about 10 km into the air. It is the thickest part in the atmosphere. Aircraft can be found in this layer as well as mountains.

Credit: nationalgeographic.org

Source: National Geographic Society

Mars' Atmosphere

Mars' atmosphere is very thin in comparison to the Earth's atmosphere. The primary gas that comprises Mars' atmosphere is CO2. This gas can be found in surprisingly large amounts in Mars' atmosphere, 95% CO2. Oxygen is less abundant, about 1%. The excessive amounts of CO2 and a lack of oxygen would kill humans, assuming that the thin atmosphere did not do so in the first place. Since there is not any plant life that we know of, photosynthesis is not taking place and therefore there are not any plants or vegetation to use as food.

Mars is the farthest terrestrial planet from the Sun which makes it colder than the Earth. The thinness of the atmosphere is also a factor which gives Mars its cold climate. Mars also has dust storms, dust devils, and snow, which is made up of frozen CO2. The dust storms are always a part of Mars' atmosphere, which is also the biggest dust storm in the solar system.

Mars' atmosphere can also be divided in layers, and they are the same as that of Earth. Mars does not have a stratosphere. The bottom layer is the troposphere, which is twice as large as Earth's troposphere. The next layer is the mesosphere, which is very cold. The next layer is the exosphere, which is extremely hot and leads to outer space.

Mars does experience seasons, but they are different from Earth's because they last considerably longer because Mars takes 687 days to revolve around the sun. Taking a look below you can see that there is a substantial difference in the average number of days each planet experiences weather in each of those seasons. *(See Table 3 Below)*

Table 3: Comparison Chart for Seasons on Mars and Earth

Mars	Days per Year	Earth	Days per Year
Spring	194	Spring	93
Summer	178	Summer	93
Fall	142	Fall	90

Winter	154	Winter	89

Credit: Mars.nasa.gov/all-about-mars/facts/mars-years/

Mars' resources are vastly different from our planet. There have been several visits from different spacecraft and rovers -- Curiosity, Perseverance, and the Ingenuity -- hoping to discover significant information to share with the world. Rocks found on the surface enabled scientists to get insight into the changes that the terrain had endured over millions of years. It was discovered that Mars had once been a wet planet.

Extrasolar Planets

Many people have had interest in outer space and the mysteries that prevail. The idea of finding something that has never been seen is truly exciting. Many have sat in the yard and looked up to the heavens star gazing hoping to find something significant and intriguing that would or could bring about world change. Maybe we would even find a planet that was comparable to ours and could house mankind as we understand it now. We are going to take a look at extrasolar planets. What does the term exoplanet mean? An extrasolar planet is a planet that revolves around a star other than the Sun.

Now, let us take a look at two particular types of extrasolar planets: Gas Giants and Water Worlds.

Gas Giants

The term gas giant is a familiar term as it refers to our large planets that revolve around the Sun beyond the Asteroid Belt. These planets are also known as our Jovian planets because of their similarity to Jupiter (Jove is the old Roman name for Jupiter) Just like our Jupiter, these planets have Hydrogen (H) and Helium (He) in their atmospheres. Many revolve very close to their stars, which makes them hot and hence the term "Hot Jupiter."

Water Worlds

This term refers to the exoplanet that is covered with water. Unlike the Earth, where only 0.02% of the mass is water, the mass of these planets can be 25%-50% or even more water. These planets are called Hycean planets. These planets are larger than Earth and can possibly be habitable. Hycean planets are hot, ocean-covered and with hydrogen-rich atmospheres, with temperatures reaching up to 392 degrees Fahrenheit (200 degrees Celsius) and are basically water worlds, says Dr. Nikku Madhusudhan the lead author on University of Cambridge's research[9] . These planets are described as having hydrogen rich atmospheres coupled with rocky cores. Life, if any, on these planets may be aquatic life because of the amount of water there.

There are smaller frozen water worlds in our solar system, and astrobiologists are looking closely at these moons: Callisto, Enceladus, Ganymede, Europa and Titan for signs of life." (See table 4 below)"

Table 4: Some interesting Solar System Moons and their Properties

Moon	Planet	Properties
Europa	Jupiter	Possible subsurface ocean.Diameter 3120 km Tidal flexing which may create heat. Possible life through chemical reactions: oxygen. Photosynthesis unlikely

Enceladus	Saturn	May have liquid water (ice)
Callisto	Jupiter	May have a subsurface ocean
Ganymede	Jupiter	May have a magnetic field, possible ice and subterranean oceans
Titan	Neptune	Possible liquid water or a subsurface ocean

Credit: https://www.sciencefocus.com

Source: Amy Godfrey

Teaching Strategies

Learning Styles Model

My chosen strategy for teaching this unit will appeal to the various learning modalities that students in my class have. David Kolb first outlined his theory of Learning Styles in 1984 in the book titled "Experiential Learning-: Experience as the Source Of Learning and Development". David Kolb believed that our individual learning styles emerged due to our genetics, life experiences and the demands of our current environment. [10]

Each lesson will be taught in different ways by which each type of learner will be able to absorb the most from the lesson. There are four learning styles or models that will help me to provide the best academic experience for my students. There will be opportunities for the visual, auditory, kinesthetic, and tactile learners to excel in the modality that best suits their learning style. Consideration will also be given to students who are diverse learners and need extra support to succeed academically. These scholars are already participating in the "Inclusion Model" which allows students to participate in a general education class, avoiding isolation issues and encouraging social bonding with their peers. The general education classroom teacher and the special education teacher work together to support the special education student academically and emotionally. The general education teacher along with the special education paraprofessional will scaffold lessons and adhere to all the accommodations that their Individual Education Plan outlines for their personal success. The Individual Education Plan outlines accommodations that will be used by both teachers to help these students have a better understanding of the lesson.

Visual

These students learn best when they are able to look at visuals. Visual learning stimulates the cortex of the brain. The strategies that will be used for these students will be the usage of charts, movies, videos, graphic organizers, comics and the use of computers. We are going to take a trip to the Adler Planetarium. Students will be able to learn a lot about outer space. They will be able to talk to professionals who will help to broaden their experiences and knowledge about the solar system.

Auditory

Auditory learners benefit most when they are able to hear information being given to them. Kanar argued that auditory learners like listening and speaking, have compatible personalities, and have difficulty in following written instructions.[11] They have to listen to an explanation and hear it to understand and learn. These people do not necessarily paint in their minds as visual learners do; on the contrary, they filter through

the ability to listen and replicate incoming information.[12] Classroom material for these learners will come in the form of discussion, songs and other audible assignments. The students will make up songs using the information that they have learned in class. The processing of information will be best acquired when they are actively engaged in auditory stimulation.

Kinesthetic/Tactile

Kinesthetic learning gives students an opportunity to move and use their hands to touch. These students get the most out of learning when they are offered a combination of learning opportunities. Students who experience ADHD find kinesthetic style of learning greatly appreciated because they can move and touch things to gain the stimulation that they need for success. The types of activities that we will be doing in class will be experiments in the lab, drawing, coloring, using the telescope.

Problem Based Learning

Problem Based Learning requires that students use their investigative skills of inquiry and problem solving to solve a real-world problem. My students acquire more understanding of their learning experience when they can relate the activity to a real-world problem. Students can actually see the relevance of learning about and exploring a situation that could personally affect them. This model works well for middle school students because they are less engaged in learning unless they can actually see how the lesson affects them.

Students will assume the role of an astronomer. They will have the task of discovering a planet that meets the qualifications for habitability. In their role as an astronomer, they will learn about planets, stars and other celestial objects in their quest for finding the "Goldilocks" planet in the habitable zone.

Room Design Model

The implementation of The Learning Styles Modalities will also be used in conjunction to The Room Design Model as described by Rita Dunn and Kenneth Dunn[13] . This model simply states that the design of the classroom will strengthen the effectiveness of each learning modality.[14] The design of the classroom will allow for small group discussion as well as peer to peer collaboration. The visual design that I will achieve in my classroom will be a setting that reminds the students that we will be experiencing a journey to outer space. Students will be able to look around them and above them and see various mobiles of planets, stars, the Moon, meteorites, asteroids and other celestial objects. The auditory learners will be listening to a soft classical selection which will remind them of music that they have heard before while watching sci-fi movies in the past. These combinations of learning modalities will stimulate and increase successful outcomes for students while they are doing their assignments.

Classroom Activities

Activity #1: Is this planet Habitable?

Objective: Students will be able to describe the properties of a habitable planet.

This game will help students use their inquiry skills using evidence that they have learned in class. Students

will have 4 cards given to them; each card will have information pertaining to a celestial body. The objective of the game is to start a Socratic discussion amongst the students. Each team will consist of 4 students and they will try to determine if any of the cards that they have, describes a habitable planet. There will be a deck of cards that has the correct information on it as it pertains to each card. This deck of cards will be spread out in the middle of the table. The other 3 players can challenge the student's information and therefore win the card if their challenge is correct. They will check the answer by getting the correct card from the middle of the table. The student with the most cards at the end of the game obtained by answering correctly or challenging is the winner. Students will also have access to their notes to help them in their discussion. Students can design the cards with different celestial bodies on them or with a theme, like a picture of a star on it. The teacher's role is that of facilitator. This game should last for approximately 60 minutes or a class period. All learning modalities will be stimulated by this activity.

Materials Needed: card stock, scissors, colored pencils

Activity #2: Space Songs

Objective: Students will use the information that they have learned to create a song about habitability.

This activity can be used by students collaborating in a group or working independently. Students will create lyrics that express their knowledge of a habitable planet. Students should include at least 2 verses and a chorus in their song. Time should be given for students to think about their lyrics for the song. Each group or individual can perform their song for the class. This lesson is going to be very beneficial to students who are stimulated from auditory learning.

Materials: paper, pencil

Activity #3: The Game of Habitable Life

Objective: Getting to the habitable planet by avoiding any setbacks

Students are going to create this game utilizing the knowledge that they have learned in class. This game will consist of a board which will be designed by students which will allow them to be the first one to get to the habitable planet. There will be setbacks on some of the spaces on the board. For instance, students could draw cards that send them back to the beginning of the pursuit or perhaps their spaceship gets hit by a meteorite. Students can also pull cards that help them to advance around the board, putting them in a position to be the first player to make it to the habitable planet. The planning and designing time for this game may take 2, one hour class periods. Tactile and kinesthetic learners will be stimulated by this game of intrigue. Students who have the least amount of setbacks will advance to the habitable planet the quickest.

Materials: cardboard, card stock, pens, colored pencils, crayons, scissors, ruler, markers

Resources

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This book gives a historical overview of research by various astronomers and scientists.

Kolb, David A. (1984) 1984. *Experiential Learning: Experience as the Source of Learning and Development*. 2nd ed. Upper Saddle River, New Jersey: Pearson Education, Inc.

This article outlines the learning modalities and how each student can be more successful if they are using the style that benefits them the most.

Resource List for Students

Brennan, Pat. “Exoplanet Exploration: Planets beyond Our Solar System.” *Exoplanet Exploration: Planets beyond Our Solar System*, NASA, 17 Dec. 2015, exoplanets.nasa.gov. Accessed 1 Aug. 2022.

This is an article that helps children to understand the meaning of the term Exoplanet. Students will also see images of planets taken by NASA.

Bristol, Jenny. “Sky Guide.” *Commonsense.org*, Common Sense Education, 2019, www.commonsense.org. Accessed 1 Aug. 2022.

This app gives students an opportunity to take a journey through the universe. Students will be able to view different celestial bodies. Students can also time travel to different dates in history to view what the sky looked like at that particular time.

“Dwarf Planets.” *Nationalgeographic.com*, National Geographic, 2019, nationalgeographic.com. Accessed 1 Aug. 2022.

This article gives a brief history of how the loss of Pluto as a planet erupted into a surge to find other dwarf planets in the solar system.

Appendix on Implementing District Standards

The standards that are used in Chicago Public Schools are the Next Generation Science Standards (NGSS). Students who display understanding and mastery of these standards will be able to use inquiry skills to obtain evidence to help them decipher patterns of evidence.[15] The standards that will be used are MS-ESS1-1, MS-ESS1.A, MS-ESS1.B, and MS-ESS1-3. Students will show mastery of these standards by demonstrating understanding of the key concepts.

MS-ESS1-1 - Students will develop and use models of the Earth as their reference as they explore other planets in the solar System.

MS-ESS1.A Students will describe the motion of the sun, the moon and stars in the sky using models

MS-ESS1.B Students will analyze and determine how the solar system formed

MS-ESS1-3-Students will analyze and interpret data to determine scale properties of objects in the solar system.

Notes

[1] Voytek, Mary."NASA Astrobiology,"NASA. Accessed July 25,2022.https//astrobiology.nasa.gov/.

[2] ibid, 45

[3] ibid

[4] Crichton, Michael and Patrick Berthon. *Jurassic Park.* Paris: Pocket,2015.

[5] 'Exoplanet Exploration: Planets beyond Our Solar System. "NASA, December 17, 2015. https://exoplanets.nasa.gov/.

[6] Perlman, Howard, and John Evans. "Water Science School." Water Science School U.S. Geological Survey, 2000. https:www.usgs.gov/water-science-school.

[7] Burkhardt Christoph, Fridolin Spitzer, Allessandro Morbidelli, Gerrit Budde, Jan H. Render, Tho mas S. Kruijer, and Thorsten Kleine. "Terrestrial Planet Formation from Lost Inner Solar System Material." *Science Advance* 7, no.52 (2021). https:doi.org/10.1126/sciadv.abj7601

[8] Williams, Dr. David R. "Lunar and Planetary Science", Accessed July 27,2022.nssdc.gsfc.nasa.gov/planet

[9] Madhusudhan, Nikku, Anjali A. Piette, and Savvas Conslantinov. "Habitability and Biosignature of the Hycean Worlds." The Astrophysical Journal 918, no.1 (2021): 1. https://doi.org/10.3847/1538-4357/abfd9c

[10] D.A. Kolb, *Experiential Learning: Experience as the Source of Learning and Development*

[11] Kanar, C.C. iosr journal 22 no.10 (October 2017) 4-10

[12] ibid, 6

[13] Dunn, Rita and Kenneth J. Dunn. *"Teaching Students through Their Individual LearningStyles*: *a Practical Approach*" Reston, Va: Reston Publ. Comp 1978 .

[14] ibid

[15] "Next Generation Science Standards", 2022