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Life on Earth and Beyond, Our Search for Answers

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INTRODUCTION

This unit is written for high school self-contained special education students. These students cannot participate in mainstream science courses for a variety of reasons. Most of my students have severe learning disabilities and read significantly below grade level. Their knowledge of Astronomy is extremely limited. Basic Astronomy concepts must be introduced during this unit and reviewed throughout the unit in order for the learning disabled student to internalize the main ideas.

The narrative information I included in this paper should be used as a guide, to be modified depending on the varying academic levels of your students. My main goal is to use the student's enthusiasm and curiosity for Astronomy to practice and refine their critical thinking skills. These essential skills will be needed long after they have graduated from high school.

Students will be given time during this unit to do independent research in the areas of Astronomy that they find most interesting. This will allow each student to work at his or her own academic level on a topic they have chosen for themselves, making them more responsible for their own learning. At the end of the unit, students will present their research projects to their classmates, giving the students a chance to learn from their peers as well as an opportunity for the teacher to assess the students understanding of the material presented and researched.

Objectives

To develop an understanding of the formation of the Universe and the Solar System.

To identify Earth's characteristics that enable it to sustain human life.

To compare the Earth's characteristics to those of the other planets within our solar system.

To determine the feasibility of space travel beyond our solar system.

To develop an appreciation for our planet Earth's resources and unique ability to sustain human life, and an understanding of the need for responsible stewardship toward our planet.

FORMATION OF THE UNIVERSE

For thousands of years humans have wondered about the beautiful lights in the dark night sky. Over time astronomers began to understand what they were seeing. Today we know the universe contains more galaxies than there are people on Earth. And each galaxy contains hundreds of billions of stars. Some of the stars are so enormous that it would take years for a spacecraft just to get from one side to the other. Some stars are no wider than a small city. Our Sun is about midway between these extremes.

The sun is a star still in its youth. Stars do not exist forever. Like people, they are born and they die. Astronomers have discovered that the entire Universe has not existed forever either. About 15 billion years ago, an enormous explosion called the "Big Bang" created as expanding bubble of energy. In the first few minutes after the Big Bang, with temperatures of at least 18,000,000 degrees Fahrenheit, nuclear reactions converted part of the hydrogen into helium. After one half million years, radiation and matter separated. Galaxies then began to form from the gas. Later, stars were born within the galaxies. One of those stars was the Sun. Astronomers estimate the sun was born 4 ½ billion years ago. Earth and the other planets of the solar system were formed along with the Sun from leftover material.

When you look up into the night sky with the naked eye, everything you see is part of the Milky Way Galaxy, our own star system. The dust within the disk of our galaxy obscures our view of other galaxies and beyond. In all other directions it is just distance that makes them faint. The galaxies are spread very thinly through the emptiness of space. They are swirling, dynamic systems in which matter comes together to form stars, planets, satellites, asteroids, and comets.

Galaxies come in different shapes and forms, most of them being elliptical. Like the Milky Way, most of the galaxies contain thousands of millions of stars. They usually have a concentration of stars towards the center, forming a bright "nucleus." Spiral galaxies have great trailing, spiral "arms" radiating from the center; the spiral arms are made up of millions of stars. Our Sun is such a star, situated in a spiral arm toward the outer edge of the Milky Way Galaxy.

Supernova Explosions

The most massive stars develop a core of iron. When the core begins to cool down, the center collapses. Following the collapse, there is a rebound, which forces a massive, "supernova" explosion that flings the star's matter out into space.

The birth and death of stars is the process that creates the chemical elements that make up everything in our world-including us. Stars operate like factories, creating these elements in the furnaces of their own contractions.

A supernova explosion can have the brightness of a million suns. It can also produce elements like uranium. All of these star-born elements eventually end up floating in space as part of gas clouds. They will in turn be the beginnings of future stars and maybe planets as well. The Big Bang produced hydrogen and helium. All other elements were created subsequently inside massive stars, and also by supernova explosions which dispersed this material throughout the universe. These processes continue to date.

FORMATION OF THE SOLAR SYSTEM

The solar system consists of the Sun and those bodies, such as planets, satellites, asteroids, and comets, which are trapped by the Sun's gravity into a variety of orbits around it. The Milky Way Galaxy had been in existence for billions of years when the Sun was born. Millions of stars had been born and died. In the gaseous swirls of the Galaxy, they left a rich "soup" of chemical elements in the form of gases and dust. These stars provided the raw materials for future stars and planets. A cloud of gas and dust began to contract, possibly triggered by the explosive death of a nearby star. As it spun, it's core became denser and heated up until it reached nuclear ignition point. The Sun was born.

The new Sun did not use up all of the available material in the rolling gas cloud from which it was formed. While the Sun began to shine with fusion reactions, particles in the cloud around it began to coalesce to form other much smaller bodies. These were the planets. Most scientists think the planets originated in the same gas and dust cloud from which the Sun condensed.

Almost certainly, as the Sun was formed, it was surrounded by a flattened, rotating disk made up of many clumps of material. A long series of collisions helped to coalesce some of these clumps into sizeable bodies. As time passed, they attracted any smaller fragments that came within range of their fields of gravity. Some heated up enough to melt as they contracted. The heavier materials then became concentrated in the central core of the objects.

The nine planets, of which the Earth is one, orbit the Sun at different speeds. Compared to the Sun, the planets are tiny. All together, they have only one-thousandth of the mass of their parent star, the Sun. Just as the planets orbit around the Sun, the moons or satellites of the Solar System rotate around their parent planets.

All planets are dark; the light that appears to shine from them is the reflected light from the Sun. The stars, on the other hand, shine with the luminosity of their own burning energy. When early stargazers began to look closely at the sky, they traced the patterns of the stars in their fixed constellations and noted the apparent movement of the constellations across the sky. By the early 1500s Nicolaus Copernicus developed the idea that the Sun was the center of the universe, with the planets orbiting around the Sun. This Sun-centered, or "heliocentric," version of the Solar System overturned the old traditional doctrine that the Earth was the center of the Solar System

THE EVOLUTION OF LIFE ON EARTH.

As the newborn Earth consolidated, its internal heat became so fierce that it caused the solids to melt. The heavier elements in the planet's make-up were drawn down into the center. Lighter elements, including gases, moved to the surface. This surface began to form a crust. Above it, an atmosphere began to form from the gases ejected through the cooling crust by the pressures within. They included carbon dioxide, nitrogen and water vapor. The Earth's gravitational pull held onto the atmosphere being created from the volcanic emissions. Volcanic steam condensed to form thick clouds that blanketed the planet. The surface continued to cool. Eventually, the clouds began to pour down rain. It was a rain that lasted for millions of years.

The rains created the first oceans. By the time the Earth's surface had cooled enough to interrupt the almost endless cycle of evaporation and condensation, the planet had begun to demonstrate its unique characteristic. It is the only body in the Solar System with a surface covered largely by water. This cover of water had a significant affect on the atmosphere. It dissolved some of the gaseous elements in the air, making the atmosphere thinner. Composed mainly of carbon dioxide and nitrogen, it also included ammonia, carbon monoxide, hydrogen and methane. There was no significant amount of oxygen yet.

Scientists who study the origins of the Earth have conducted many experiments. Gases found in the early atmosphere have been mixed with water and subjected to certain natural traumas such as ultraviolet radiation and the high voltage discharges typical of electrical storms and lightning bolts. Complex substances have been found as a result. These materials include carbon chemicals and amino acids. Both are fundamental to living matter. The warm, shallow lakes and ocean margins were ideal for the beginning of life. The water stewed, waiting for the right exposure to ultraviolet rays from the Sun, or lightning strikes from the rumbling clouds. Once the new, biologically active, molecular chains were set in motion, they could sink into the protective depths of their watery environment. There, protected from prolonged exposure to harmful ultraviolet radiation, they could begin to evolve.

Blue-green bacteria were Earth's predominant life form long before humans ever existed on Earth. Over hundreds of millions of years, the bacteria colonized the planet. Through a process similar to photosynthesis, these primitive cells released oxygen, which they extracted from oxygen compounds into the atmosphere. This process radically altered the atmosphere of the Earth. The way was cleared for oxygen-consuming organisms to develop.

Oxygen also built a protective barrier of ozone. This is a special form of oxygen that is found only in the upper levels of the atmosphere. It shields living things from the Sun's ultraviolet rays. Life forms that could leave the protection of the water and exist on dry land were now able to develop. Volcanoes are one of many signs that the Earth's interior is hot. On the beds of oceans, there are ridges where plates move apart. The gap is constantly replenished with molten rock from below. The motion sometimes sticks along the slip lines. When it jolts onward again, an earthquake may accompany the sudden movement.

The Earth's atmosphere is as unique as its water cover and shifting crust. The air breathed at ground level is 78.08% nitrogen, 20.94% oxygen, 0.93% argon, and varying amounts of water vapor and other gases. In the upper atmosphere, solar ultraviolet radiation changes some of the oxygen into ozone. The ozone absorbs ultraviolet radiation. This helps to protect life from unfiltered ultraviolet radiation, which would destroy it. The "greenhouse" gases in our atmosphere help to seal in the weather below. The air around the Earth also acts as a friction shield. It burns up the billions of meteors that bombard the planet every day, most the size of specks of dust.

SIGNS OF LIFE IN OUR SOLAR SYSTEM?

Mercury, our innermost planet, orbits very close to the Sun. A point on the daylight side of Mercury receives sunlight for so long, and from such a close distance to the sun, that the maximum temperature reaches over 400 degrees centigrade (800* F.). Mercury has practically no atmosphere to spread the energy around the planet. Traces of sodium making a very thin atmosphere around Mercury were discovered fairly recently. But for the most part, sunlight gives particles near Mercury so much energy that they escape from Mercury's weak gravity. Photographs from NASA's Mariner 10, showed that Mercury is covered with craters and fine dust that has a small magnetic field. Mercury has no moon.

Venus comes nearer to Earth than any other planet. It most closely matches Earth in size, mass and density. The clouds in Venus's atmosphere allow sunlight to pass through. The sunlight heats Venus's surface, which gives off mainly infrared rays. Unlike sunlight, these infrared rays cannot pass up and out through the clouds. The atmosphere of Venus traps the energy of the infrared radiation and the planet heats up. The process is known as the "greenhouse effect". The "greenhouse effect" found on Venus is very different from that found on Earth. Venus has over 90% of it's atmosphere made up of carbon dioxide, giving it a very large "greenhouse effect", with temperatures hot enough to melt lead. On Earth, carbon dioxide is only about 300 parts per million.

Venus's surface appears to have giant volcanoes. Studies of Venus's atmosphere have also shown changes in the level of certain gases that seem to show that volcanoes are currently active on Venus. Although, no actual eruptions have been seen. Venus rotates much slower than the Earth, and has no moon. It has no magnetic field or drifting continental plates. Mars is smaller than Earth; its diameter is only about one-half of the Earth's diameter and has only one-tenth the Earth's mass. Mars rotates at almost the same rate as Earth, and its rotation axis is inclined to the ecliptic at almost the same angle as the Earth's axis. Because of its axis tilt, Mars has daily and seasonal cycles similar to those on Earth.

Mars has polar ice caps that grow and diminish as the seasons change. One Martian year lasts 780 Earth days, or two Earth years and two months. The appearance of the planet changes because of seasonal dust storms that obscure its surface. Dust storms on Mars can be studied from Earth. Amateur astronomers keep track of them. Studies of the weather on Mars are helping us understand our own weather system on Earth.

Evidence reveals that liquid water once existed in great quantity on the surface of Mars. Two types of flow features are seen, the run off channels and the outflow channels. They bear a strong resemblance to river systems on Earth, and geologists believe that this is just what they are. There is no evidence of liquid water today, and in fact it could not exist on its surface, since the melting temperature coincides with the boiling temperature. All of the water on Mars today is locked in the permafrost layer under the surface, and perhaps in the polar caps. Mars has no magnetic field. Since the planet rotates rapidly, this implies that its core is nonmetallic, nonliquid or both.

Mars has two tiny moons, which are probably asteroids that were captured, by the planet's gravitational field early in its history.

Jupiter is the largest planet in the solar system. Its mass is more than twice the mass of all the other planets combined, although it is still about 1000 times less massive than the Sun. It is composed primarily of hydrogen and helium gas.

Jupiter rotates very fast, producing a pronounced equatorial flattening. The amount of flattening allows astronomers to infer the presence of a large core in its interior.

Jupiter's atmosphere consists of three main cloud layers. The colors that we see are the result of chemical reactions, fueled by the planet's interior heat, solar ultraviolet radiation, auroral phenomena, and lightening, at varying depths below the cloud tops, seen through "holes" in the overlying clouds. The main weather pattern on Jupiter is the Great Red Spot, an Earth-size hurricane that has been raging for at least three centuries. Other, smaller, weather systems-the white and brown ovals-are also observed. They can persist for decades.

Jupiter's atmosphere becomes hotter and denser with depth, eventually becoming liquid. Interior pressures are so high that the hydrogen is "metallic" in nature near the center. The planet has a large "terrestrial" core 10-20 times the mass of the Earth.

The magnetosphere of Jupiter is about a million times more voluminous than Earth's magnetosphere, and the planet has a long magnetic "tail" extending away from the Sun to at least the distance of Saturn's orbit.

Jupiter and its system of moons resemble a small solar system. Sixteen moons have been discovered so far. The innermost Galilean moon, Io, has active volcanoes. Europa has a cracked, icy surface that may possibly conceal an ocean of liquid water. Ganymede, the largest moon in the solar system, shows some evidence for past geological activity, but it is now unmoving rock and ice.

Saturn is smaller than Jupiter, but still much larger than any of the inner planets. Like all jovian planets, Saturn has many moons and a planetary ring system around it.

Weather systems are seen on Saturn, as on Jupiter, although they are less distinct. Saturn has weaker gravity and a more extended atmosphere than Jupiter. The planet's overall butterscotch hue is due to cloud chemistry similar to that occurring in Jupiter's atmosphere.

Saturn's rings are made up of trillions of icy particles ranging in size from dust grains to boulders, all orbiting Saturn like so many tiny moons. Their total mass is comparable to that of a small moon. Many scientists believe that planetary rings have a lifetime of only a few tens of millions of years. The fact that we see rings around all four jovian planets means that they must constantly be reformed or replenished, perhaps by material chipped off moons by meteoritic impact or by the tidal destruction of entire moons.

Saturn has the most extensive system of natural satellites of all the planets. It has at least 19. The reflected light from Saturn's moons suggests that most are covered with snow and ice. Saturn's largest moon Titan is the second-largest moon in the solar system. Titan is the size of the planet Mercury.

Uranus, the seventh planet from the Sun is smaller than Saturn, but still four times the diameter of the Earth. Uranus orbits about twice as far out from the Sun as Saturn. Uranus takes 84 of our years to orbit the Sun.

Uranus itself shows very little structure on its surface. It appears blue-green because the methane gas in its atmosphere absorbs all the other colors in the sunlight that hits it. Uranus has atmospheric clouds and flow patterns that move around the planet in the same sense as the planet's rotation, with wind speeds in the range of 200-500 km/h. Voyager 2 found that Uranus and Neptune both have magnetospheres comparable in strength to Earth's field. Theoretical models indicate that Uranus and Neptune have rocky cores similar to those found in Jupiter and Saturn.

Uranus is known to have 17 moons. The frequency of large craters on the outer moons suggests that destructive impacts may once have been common in the Uranus system.

Neptune orbits the Sun once every 164.8 Earth years. It has not completed one revolution since its discovery. Neptune is so distant that surface features are impossible to discern.

In 1989, Voyager 2 revealed a Great Dark Spot on Neptune, a spiral storm the size of Earth. (Later, in 1994 the Hubble Space Telescope viewed Neptune and found the Spot had disappeared.) Neptune has several storm systems similar to those found on Jupiter.

Spectroscopic studies of sunlight reflected from Uranus and Neptune's dense clouds indicate that the two planets' outer atmospheres are similar to those of Jupiter and Saturn. The most abundant element being hydrogen, followed by helium and methane, which is more abundant on Neptune than on Uranus.

Neptune has 8 known moons. Its largest moon, Triton, has an atmosphere, which is made up of mostly nitrogen, like Earth's. But Triton is much colder. Triton's surface temperature is 37K, making it the coldest place in our solar system. Triton's surface consists primarily of water ice. The cameras on Voyager 2 detected two great jets of nitrogen gas erupting from below the surface, rising several kilometers into the sky. Scientists conjecture that nitrogen geysers may be very common on Triton and are perhaps responsible for much of the moon's thin atmosphere.

Pluto is a small planet with a solid surface just past large gaseous planets. Pluto's orbit is quite elongated. Because of its substantial orbital eccentricity, Pluto's distance from the Sun varies considerably. At perihelion, it lies 29.7 AU. (4.4billion km) from the Sun, inside the orbit of Neptune. At aphelion, the distance is 49.3 AU. (7.4 billion km), well outside Neptune's orbit. At 40 AU. from the Sun it is never visible by the naked eye. It takes Pluto 247.7 Earth years to make one revolution around the Sun.

Pluto's great distance from Earth makes it very difficult to study its physical nature. In July 1978 astronomers at the U.S. Naval Observatory discovered that Pluto has a satellite. It is now named Charon. Knowing the moon's orbital period of 6.4 days, astronomers could determine the mass of Pluto accurately. It is 0.0025 Earth masses, more similar to the mass of a moon than a planet. Because Pluto does not possess characteristics of either terrestrial or jovian planets and because of its similarity to the ice moons of the outer planets, some researchers suspect that Pluto is not a "true" planet. Pluto may be an escaped planetary moon or a large icy chunk of debris left over from the formation of the solar system.

Our Sun is a star. It is a fairly average star, but unique in its location to Earth. It is some 300,000 times closer than out next nearest neighbor Alpha Centauri. While Alpha Centauri is at a distance of 4.3 light years distance, the Sun is only 8 light minutes away from us.

A star is a glowing ball of gas held together by its own gravity and powered by nuclear fusion at its center. The main interior region of the Sun is the core, where nuclear reactions generate energy. The Sun generates this energy by "burning" hydrogen into helium in its core by the process of nuclear fusion. When four protons are converted into a helium nucleus in the proton-proton chain, some mass is lost. The law of conservation of mass and energy requires that this mass appear as energy, eventually resulting in the light that we see.

The sun is 870,000 miles across. A million Earth could fit inside it. The everyday surface of the Sun that lights up our daytime sky is called the photosphere. It is too bright to stare at safely. Scientists and amateur astronomers either project an image of the Sun onto a screen or use special filters that cut out all but about one-millionth of the Sun's light.

STARFLIGHT AND INHABITABLE PLANETS

For far too long man has been under the misconception that our planet Earth has an infinite supply of resources and space to service our growing population. With our population soon approaching 6 billion, the urgency of conserving natural resources is becoming of great importance.

Some people believe space exploration may hold the answers to our population explosion. What are the chances of another planet existing in our galaxy so similar to Earth that we could hope to colonize such a planet? If the Sun is considered to be an average star, and planets seem to form around stars naturally, then planets at our temperature range should turn out to look similar to Earth. Life on these planets should be based on carbon, oxygen, and water. Given enough time and natural forces, the same evolution that occurred on Earth could occur on similar planets.

The question in not: Are there worlds out there that could sustain human life? The question that needs to be answered is: Is it possible to travel to these distant worlds?

A rocket would have to reach a burnout speed of nearly 58,000 kilometers per hour to escape from the Sun's gravitational influence. The best we have been able to achieve to date is somewhere around 40,000 kilometers per hour, for the rockets that have gone to that moon and the planets. Even if a rocket could keep going at its top speed of 58,000 kilometers per hour-which it won't, once the rocket engines shut down-it would take 80,000 years to reach Alpha Centauri, the next nearest star. This is the closest star to our solar system, 4.3 light years away. Even if we could travel at the speed of light-which is 300,000 kilometers per second-it would take 4.3 years to get there. (Nothing in the Universe has been observed to travel faster than the speed of light.)

Let's just assume for a moment that we could build a ship that could travel at the speed of light, the ship would still have to carry its propellant fuel with it. The rocket would spend a considerable amount of its energy just lifting its own fuel mass. As long as you have to carry all the rocket's propellant along with you, any increase in speed must be paid for by more propellant mass. This is a major obstacle to traveling at the speed of light. Even if you could overcome this obstacle, you would have to leave the Earth, knowing that the ship would return to a world that is several thousand years older than the one you left. In reality you would be taking a one way trip.

RADIO WAVES IN SPACE

Optical telescopes are limited to those wavelengths that the human eye can detect. However, information also comes to us at other wavelengths. In addition to the visible radiation that normally penetrates the Earth's atmosphere on a clear day, radio radiation also reaches the ground. Radio astronomers have built many ground-based radio telescopes capable of detecting cosmic radio waves. These devices have all been constructed since the 1950s. Radio astronomy is a much younger subject than optical astronomy.

Radio messages would be a much more practical way to find out if intelligent life forms exist in space. Dr. Sabatino Sofia, professor of Astronomy, gave the following analogy in comparing space travel and radio astronomy: "If you wanted to find out information about someone in Europe, would you take an airplane and travel there or would you pick up the telephone and call the person?"

In 1960, radio Astronomers observatory on Green Bank, West Virginia studied the radio emissions coming from two relatively nearby stars. Both of these stars were about 10 light years from Earth and both were thought to be the type of star that is long-lived and stable enough to allow life to develop. There was no evidence of planets around either stars, but that doesn't mean that there are none. At such distances from us, planets are too small and dim to detect.

Radio and other nonoptical telescopes are essential to study of the Universe because they allow astronomers to probe regions of space that are completely opaque to visible light and to study the many objects that emit little or no optical radiation at all.

TEACHING STRATEGIES

Critical Thinking

The major thrust of this unit is to have my students work towards mastering critical thinking skills. The following strategies are recognized as "hallmarks" of teaching critical thinking (Beyer, 1985; Costa, 1985):

> *Promoting interaction among students as they learn-Learning in group setting often helps each member achieve more.

> *Asking open-ended questions that do not assume the "one right answer". Critical thinking is often exemplified best when the problems are inherently ill-defined and do not have a "right" answer. Open-ended questions also encourage students to think and respond creatively, without fear of giving the "wrong" answer.

> *Allowing sufficient time for students to reflect on the questions asked or problems posed. Critical thinking seldom involves snap judgments; therefore, posing questions and allowing adequate time before soliciting responses helps students understand that they are expected to deliberate and to ponder, and that the immediate response is not always the best response.

> *Teaching for transfer - The skills for critical thinking should "travel well". They generally will do so only if teachers provide opportunities for students to see how a newly acquired skill can apply

to other situations and to the student's own experience.

Communicate the Goal of the Lesson

"Low-achieving students learn best when teachers make reference to what is being learned, why it is important, and if appropriate, how it relates to other learning." (Lesson Structure: Research to Practice, Eric Digest #448).

Students with learning disabilities need to be exposed to the same material many more times than their non-disabled peers before mastering the concepts. Teachers need to explain this to students. If students are unaware of these differences, they can often become frustrated and give up too soon. I explain to my students that learning disabled students will often see mastery of a concept come in one big jump, after many failures. Where as non-disabled students will experience small, gradual increments of mastery through out.

Typical learning curve for non-disabled Typical learning curve for learning

student. Disabled student

I discuss the above diagram with my students and explain that with patience and perseverance they will master the concepts presented. I start each lesson with a review of the previous lesson, paying special attention to vocabulary. I will spend the first few minutes of every class reviewing vocabulary and showing visual prompts to help student internalize important concepts. Many learning disabled students have severe language and memory deficits, which makes vocabulary review essential to accurate communication of concepts. Learning disabled students can sometimes be accused of daydreaming, or not trying hard enough when in reality they need much more exposure to the material.

Assessment

The assessment techniques we choose will play a vital role in the success or failure of our students. Limited, inappropriate assessment tools can often result in the segregation and devaluing of groups of children in our classroom.

Assessment should be used as a learning tool, for both teacher and student, which evaluate multiple concepts, and understanding. Assessment should serve as a means to helping teachers to understand what their students know and how to plan future curriculum. Too many existing assessment tools are limited, rather than wholistic. They often focus on what students don't know, instead of giving open-ended problems that give students opportunities to use their strengths to discover new concepts. Throughout this unit multiple assessment techniques such as writing, group work, discussions, demonstration models, and real life problem solving will be used to assess student mastery of material presented.

CLASSROOM ACTIVITIES

Astronomy Current Events One day per week will be dedicated to Astronomy current events. This will help build critical thinking skills as well as encourage students to analyze information presented to them by the media. Teacher selected articles can be used or students can be required to find articles in newspapers and periodicals as homework assignments. When students bring in articles they should be photocopied so the class works on the same single article together. The extra articles should be saved for future weeks.

Materials

Current Events Journal

Photocopies for each student of a current Astronomy article

Procedures

1. Students take turns reading parts of article aloud. Students can ask for clarification of article's content at this time.
2. Students are broken into groups with each group having no more than 4 students.
3. Each student will write a detailed summary of the article and a one-paragraph opinion of the same article in their current events journal.
4. In each group, students should act as peer tutors helping each other with spelling, writing, or formulating ideas, while the teacher circulates around the room.
5. All students in group share their summaries and opinion.
6. Entire class discusses article, and verbally tells teacher what facts are important for an accurate summary.
7. Teacher writes summary on board, Students can make changes to their own at this time, but it is not mandatory.

Variation

As students become proficient at writing clear, accurate summaries and thoughtful opinion paragraphs, the teacher can give each group a different article. When groups are finished writing their summaries and opinions, their group will give a short presentation to the class about their article.

Solar System Research

The students' first research project will use children's books as resources. Many of my students read at a third grade reading level or lower. Using children's books will allow them to engage in research at a more appropriate reading level, while reinforcing astronomy concepts in simple, less technical terms. As not to embarrass my students with the use of children's books, I will tell my students they are going to make a children's riddle book about our solar system for a nearby elementary school. And that I need them to use some of the same books that would be found in these elementary classrooms. Students will receive a planet research worksheet that will guide their research which should include questions such as: planet diameter, distance from the Sun and Earth, length of day and year, temperature, weather, evidence of volcanoes, composition of planet's atmosphere and interior, existing magnetosphere, and special features.

Materials

- Astronomy related children's books
- Planet research worksheet
- 16 large pieces of black construction paper
- One large package of multi colored construction paper
- Glue
- Research folder

Procedures

1. Students will be broken into 4 groups each group having 4 students.
2. Each group will pick the names of two planets from a bag, which contains names of the planets in our solar system (excluding Earth).
3. Each research group must complete their planet worksheet by using resources provided by teacher.
4. The teacher will give examples of planet riddles and show the class a completed riddle and collage for the planet Earth, which will later become one of the pages for their children's book. The riddle should be on one page of black construction paper and the collage of the planet depicted in space on another piece of black construction paper. The planet should be movable so it can be lifted up for the child to find the answer to the riddle. You can do this by tracing duplicate shapes for your planets, glue only part of the second shape directly on top of your first planet, which will be completely glued to your black construction paper.
5. Students will present their research and children's riddle pages to their class.
6. Teacher will bind all pages into a book.
7. Students will bring the completed book to an elementary class and introduce astronomy concepts to younger students.

Variation

Instead of making a child's riddle book, students can create travel brochures with illustrations and descriptive narratives about each planet. Students should be encouraged to try to really sell the trip to consumers. For example: VENUS, the sun worshipers paradise. Including important items to bring along. What number sun-screen would be brought with you to Venus?

Research the Universe

After researching their own solar system, students must pick another topic they want to learn more about in the field of Astronomy. Students can work alone or in a group. We will spend the first class discussing topics, and procedures for this project. Students must pick 4 possible topics by the end of the first class. After skimming information on their 4 topics they must choose one topic to research. The student should be encouraged to seek out answers to questions of great interest to them. I want my students to value their own questions more than the teacher's. Some students will need extra time and guidance before finding a topic that truly interests them. All students will be required to complete a written report with rough draft and bibliography, as well as create a visual aid to go along with the report. Students are allowed to include guest speakers and or educational videos in their final presentations.

Materials

- Research folders
- Astronomy books and periodicals
- Computer with internet access
- Student selected art supplies

Procedure

1. Student will choose one topic in Astronomy he or she wishes to research. Students with common interests may work together.
2. Students need to use multiple resources for their research such as books, periodicals, internet resources, and expert guest speakers in the field of astronomy.
3. Students must meet with the teacher periodically to discuss progress of project. Students will meet as a class to share ideas, resources, and problems they are encountering while doing this research.
4. Each student or group of students will present their research to the class.

Student Debate

The teacher and students will discuss controversial issues in Astronomy, such as "Does man belong in space?" and "Should the U.S. invest in the International Space Station?" etc. The teacher and students will check periodicals, write to Astronomy organizations, as well as search the internet for information on controversial issues in Astronomy. The class will vote one topic to debate.

Materials

- Video camera
- Library resources
- Computer with internet access

Procedure

1. The class will be broken up into two teams.
2. Each team will research opposing sides of the same topic.
3. The teacher will monitor progress and help students write a script for a simulated debate.
4. Students will be given roles to act out in their debate such as scientist, taxpayer, politician, astronaut, NASA employee, etc.
5. The teacher will be the moderator, while a student films the debate.
6. The class will view the film version of their debate and discuss strengths and weaknesses of each team.

Bibliography for Teachers:

Chaisson, Eric and McMillan, Steve: Astronomy Today. Prentice Hall, Inc. 1997. Ronan, Colin, A: The Universe Explained. Saunders College Publishing. 1983. Scheighauser, Charles: Astronomy from A to Z, A Dictionary of Celestial Objects and Ideas. Springfield, Illinois: Illinois Issues. 1991. Angel, Roger and Woolf, Neville: Scientific American "Searching for Life in Other Solar Systems." May 1998. Pages 22-25 Jakosky, Bruce: Scientific American: "Searching for Life in Our Solar System." May 1998. Pages 16-21 Evans, Barry: The Wrong-Way Comet and Other Mysteries of Our Solar System. Tab Books, Blue Ridge Summit, PA. 1992. Starr, Cesie: Biology, Concepts and Applications. Wadsworth Publishing, Belmont California, 2nd Edition 1994.

Student Reading List:

Krupp, E. C.: The Big Dipper and You. William Marrow and Company Inc. 1989 Brewer, Duncan: Planet Earth and he Universe. Marshall Cavendish Corporation. 1992 Jobb, Jamie: The Night Sky Book. Little, Brown and Company, Boston. 1977 Rosen, Sidney: How Far is a Star? Carolrhoda Books, Inc., Minneapolis. 1992

Aronson, Billy: Meteors: the truth behind shooting stars. Grolier Publishing. 1996

Branley, Franklyn: Sunshine Makes the Seasons. Thomas Y. Cromwell Junior Books, New York. 1985 Marsh, Carole: Asteroids, Comets, and Meteors. Henry Holt and Company NC. 1996

Internet Resources

Quest is the home of NASA'S K-12 internet initiative, one of the electronic resources that the agency has developed for the educational community. One of Quest's most unique endeavors is the "Sharing NASA" on-line interactive project. Students and educators are given the opportunity to communicate with NASA scientists and researchers to experience the excitement of real science in real-time. Quest can be accessed via the internet at http://quest.arc.nasa.gov Teachers Guide-Live from the Hubble Space Telescope http://quest.arc.nasa.gov:80/hst/tg/contents.html "Space based Astronomy" and other astronomy activities: http://spacelink.msfc,nasa.gov/html/Instructional.Materials.html