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The Science and Technology of the Apollo Space Program

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Overview

"Traveling to the most forbidding environment known to man, twelve courageous men stepped out of their tiny space craft and onto another world. They found blistering sunshine and subzero shadows, an airless environment with a savage landscape. And with those steps, the whole history of exploration was written" (Pyle 1005).

This curriculum unit, The Science and Technology of the Apollo Space Program is written for 5 th Grade students in English as a Second Language (ESL) class. The unit could be adapted for the mainstreamed students. I will teach the students major events in the history and the science involved in the Apollo Space Program. These major events in the Space Program took place from 1963-1972. The unit will expose ESL students to science content through concrete examples and help them to make connections among the science disciplines. Not only will the ESL students demonstrate an understanding of the history of the Apollo Space Program but reading nonfiction books will increase their vocabulary, develop their fluency and improve their sentence structure.

For second language learners, the unit will help students increase their English proficiency skills in listening, speaking, reading and writing. It will be designed to prepare them to participate in the mainstreamed content area instruction. Science is the particular content area. I will teach this topic by using visual aids from NASA, researching through the Internet, and doing hands on activities or experiments.

There were six missions that explored the Moon and collected scientific data. These were the Apollos 11, 12, 13, 14, 15, 16 and 17. These missions, all of which but one landed on the Moon, collected an enormous amount of scientific data and almost 400 kilograms of rock samples. The missions that orbited to test the Command and Lunar Modules were Apollos 7 and 9. Apollos 8 and 10 orbited the Moon and returned pictures of the Moon's surface. Apollo 13 was unsuccessful with its lunar landing because of a malfunction, but it returned with pictures of the Moon's surface.

Students will learn that the Apollo Program was designed to send astronauts to the Moon and return them safely back to Earth. Students will learn from the unit that the Apollo Lunar Missions were as follows: Apollo 8, 10,11, 12,13,14,15,16, and 17. Apollo 8 was launched on December 21, 1968. It orbited the Moon and returned to Earth on December 27, 1968. Apollo 10 was launched on May 18, 1969. It orbited the Moon and

returned to Earth on May 26, 1968. Apollo 11 was launched on July 16, 1968. It landed on the Moon at the Sea of Tranquillity and returned to Earth on July 20, 1969. Apollo 12 was launched on November 14, 1969 and landed on the Moon at the Oceans of Storms. It returned to Earth on November 24, 1969. After the Apollo 13 failure, all subsequent

Apollo missions successfully landed on the Moon and returned with soil and rock samples.

I teach ESL at Codwell Elementary School. Codwell Elementary School is one of Houston Independent School District (HISD) schools in the south of Houston. It is identified as a Theater and Fine Arts Magnet School from Pre K - 5 th Grade. The students are predominantly African American and five percent Hispanic. The students live in single homes and apartment buildings. Their scholastic achievement ranges from gifted and talented to below average. Due to time constraints and the complexity of the program, this Lunar Landing unit will be taught in about three weeks.

Rationale

The Apollo Program History

The Apollo Space Program was the United States' third crewed series of Space- flight missions. The three goals of the Apollo Space Program were the following: land a man on the lunar surface, explore the lunar surface for as much useful scientific information as possible, and devise the technology to allow humans to work in the Moon's environment, and to elevate the role of the United States as a renowned force in the space race.

According to the National Aeronautics and Space Administration (NASA), the Apollo Program included a large number of uncrewed test missions and 11 crewed missions. The 11 crewed missions included two Earth orbiting missions, two lunar orbiting missions, a lunar swingby and six Moon landing missions.

The Apollo Space Program was designed to land humans on the Moon and bring them safely back to Earth. Six of the missions achieved their goals namely Apollos 11, 12, 14, 15, 16 and 17. The successful lunar surface experiments comprised of soil mechanics, meteoroids, seismic, heat flow, lunar ranging, magnetic fields and solar wind experiments.

Apollo 7 tested the Command Module (CM). Apollo 9 tested both the Command Module and the Lunar Module. Apollos 7 and 9 were the Earth orbiting missions. Apollos 8 and 10 tested various components while orbiting the Moon and returned to Earth with photographs of the lunar surface. As stated earlier, Apollo 13 did not land on the lunar surface due to a malfunction, but during the brief orbit around the Moon, the crew was able to collect photographs (NASA).

The Eisenhower Administration in the late 1950s originally conceived the Apollo Program as a follow up to the United States of America's Mercury program. During that time the Mercury capsule could support one astronaut on a limited orbital mission. However, the Apollo Spacecraft would be capable of carrying three astronauts on a circumlunar flight and could even land on the Moon's surface. Abe Silverstein, the program manager, named the program after the Greek god of the Sun Apollo. He later commented that naming the spacecraft was like naming his baby. Although NASA planned ahead for Apollo during President Eisenhower's administration, the program was not approved for implementation at that time.

John F. Kennedy was elected President on November 1960. During his presidential campaign, he promised American superiority over the Soviet Union in the areas of space exploration and missile defense. He used space exploration as a symbol of national prestige. President Kennedy warned the people of a "missile gap" between America and the Soviet Union. He pledged that the United States would always be the first in technological achievement. However, President Kennedy did not decide promptly on the status of the Apollo program. He had limited knowledge about the technical details of the Apollo, and was put off by the huge amount of funding required. Although the president approved the thirty percent budget of Project Apollo, he deferred his decision to start it.

Only when the Soviet Union sent the Soviet cosmonaut Yuri Gagarin on Vostok 1 to fly into space on April 12, 1961, did President Kennedy give his full commitment to the program. President Kennedy's goal was to land the astronauts on the Moon and bring them back safely to Earth by the end of the decade, ahead of the Russians.

Then in 1965, Alexei Leonov, a Russian cosmonaut, became the first man to walk in space. It looked like the Russians might also be the first to reach the Moon. This event reinforced American fears about being left behind in a space program competition with the Soviet Union. Space became the highest priority project. People from all walks of life worked together in full force. Men of science and industry, academics and engineers, politicians and dreamers united in an unlikely coalition to reach the ultimate target, the Moon.

Apollo 1

As a result of the people's coalition, the first Apollo spacecraft was built and officially named as Apollo 1. It was first set on top of a rocket in late 1966. On a fateful day in January 1967, astronauts Virgil "Gus" Grissom, Roger Chaffee and Ed White sat within the metal craft. The rocket was not fueled and the usual streaming vapors did not trail from its innards. There were no crowds surrounding Cape Kennedy in Florida (Pyle 13). It looked like an ordinary spacecraft testing. Although one of the astronauts complained that the spacecraft was built poorly and would be extremely dangerous for space travel, no one thought that the spacecraft was truly dangerous. For communication purposes, the Apollo 1 crew tried to make the radio work.

Commander Gus Grissom was assigned to be on the first Apollo mission to orbit the Earth. He sat beside Ed White, the Lunar Module (LM) pilot and Grissom's Command Module (CM) pilot Ed Chaffee. Commander Grissom was displeased at the way communication was handling the radio system. He commented that if he could not communicate with the controllers located between three buildings, how could they reach the Moon?

Shortly afterwards, the controllers heard Commander Grissom's words: there was fire in the cockpit. In a span of thirty seconds, Apollo 1 astronauts had been scorched and asphyxiated. Extreme heat and pressure build up were the results of the capsule fire. It took only a minute to tear open the hull of the capsule. The spacecraft technicians were unable to unscrew the many bolts that held the latch. There was no way the astronauts could escape.

The investigation of the tragic Apollo 1 went underway. Pure oxygen had been pumped in the capsule for the test. There were loose connections and wrongly routed wirings. There were also many flammable materials such as nylon and Velcro. In an environment where pure oxygen is pressurized, a bomb is created. The astronauts' death was caused when a spark cracked from one of the wire bundles beneath the astronauts' couches. They met their untimely deaths. The tragedy of the Apollo 1 mission accelerated the improvement of the Command Module, which would bring man safely back to Earth.

The Lunar Landing Manned Missions

Apollo 11 on July 1969: Mare Tranquillitatis (The Sea of Tranquillity)

On July 20, 1969 the Apollo 11 voyage achieved one of man's greatest dreams, landing on the lunar surface. The mission of landing on the lunar surface was very challenging. It was almost aborted due to an alarm that indicated a computer overload. The mission succeeded because of the bravery and the strong determination of the astronauts and the ground crew members that manned the Apollo 11.

The landing site on the lunar surface was the Sea of Tranquillity or the Latin translation Mare Tranquillitatis. The vast, Sun blasted plains of the Sea of Tranquillity stretched as far as the eyes could see. It was hundreds of miles wide and seemed like the perfect place for the first lunar landing. The Sea of Tranquillity was smooth, flat and relatively unmarred by dangerous craters. Above the Sea of Tranquillity was the oddly shaped Apollo 11 spacecraft that looked like a robotic spider. In its five billion year history, this was only the second time that such a spacecraft had orbited the airless Moon. The spacecraft would attempt to land. Below the fast moving Apollo 11, the surface of the Moon remained cold and silent.

The opposite happened to the skies above, where the Lunar Module *Eagle* was transitioning from a calm orbit to a very exciting landing. Two of the best astronauts NASA had to offer (Pyle 43) were using every bit of their skill and training to complete the goal. They wanted to achieve the honor of being the first Apollo mission that landed on the Moon. The Spacecraft landed safely at 4:18 p.m. EDT. Armstrong uttered, "Houston, Tranquillity Base here. The Eagle has landed". At Mission Control, flight control Gene Krantz was speechless. The mission control crew was elated. Krantz realized that after 8 years of effort and billions of dollars, Apollo 11 was on the Moon. Back to the lunar surface, after the landing, the astronauts ate their first meal and they decided to begin their lunar exploration earlier than planned.

There was a lunar camera that took photographs and provided live television coverage of Apollo 11. Commander Neil Armstrong set foot on the Moon's surface at 10:56 p.m. As soon as Armstrong stepped on the lunar surface, he proclaimed the famous quotation, "That's one small step for a man, one giant leap for mankind". Behind Armstrong was Buzz Aldrin, Lunar Module pilot. Full of confidence, he calculated his ability to move about rapidly. The landing on the lunar surface yielded 23.5 kilograms (47 pounds) of lunar materials. Michael Collins orbited overhead in the Command Module. The astronauts explored the lunar surface for 2.5 hours and then reentered the Lunar Module. America had officially claimed the Moon first for all mankind.

One hundred and twenty eight hours later the Lunar Module docked with the Command and Service Module. The crew transferred into the Command and Service Modules. According to NASA the ascent stage was jettisoned as the astronauts prepared for trans- Earth injection. Only one midcourse correction was required and passive thermal control was used for most of the trans-Earth coast. Apollo 11 entered Earth's atmosphere safely. The Command Module landed in the Pacific Ocean. Apollo 11's successful flight to the Moon accomplished the national goal, to land men on the Moon and return them safely back to Earth. Man's first landing on the lunar surface marked the first manned exploration beyond Earth's orbit, and was now a part of the history books.

President John F. Kennedy's goal to land a man on the Moon within the decade was fulfilled. The successful lunar landing of Apollo 11 brought the highest honor to the United States as the first country that sent 3 men to the Moon and brought them back safely to Earth. The next 5 missions of Apollos 12, 14, 15, 16 and 17 were

all very similar and also devised the technology to allow humans to work on the Moon's environment. The missions continued to elevate the role of the United States in the space race.

Apollo 12 on November 1969: Oceanus Procellarum (The Ocean of Storms)

Four months after the first Moon landing, another crew landed on the rocky surface. The Command Module Pilot, Richard Gordon Jr., remained in the lunar orbit while Commander Charles Conrad Jr. and Lunar Module Pilot Alan Bean collected lunar soil and surface samples. The two astronauts were directed to set down close to the lunar probe Surveyor III, which had landed there three years earlier. The lunar landing site was halfway across the Sea of Tranquillity. The Apollo 12 mission was the first opportunity in the scientific exploration of the Moon to sample extensively the rocks within half a kilometer from the landing site.

Apollo 13

Apart from the tragic fire on board Apollo 1, the Apollo 13 mission was the closest NASA came to a major disaster in the lunar landing program. When the astronauts were 321,000 kilometers (200,000 miles) from Earth they heard a loud bang! A Service Module oxygen tank blew up aboard Apollo 13. The Command Module's normal supply of electricity, light and water was lost. Commander James Lovell gasped, "Ah, Houston, we've had a problem". While looking outside, Lovell reported to Mission Control in Houston, Texas "We are venting something out into the - space ". Houston Mission Control replied that it was oxygen gas escaping at a high rate from the second, and last, oxygen tank (NASA).

According to NASA reports, Commander Lovell, Fred Haise, and John "Jack" Swigert and ground Mission Control had an enormous task to complete so that the astronauts could return safely. The astronauts had to move to the Lunar Module to escape the decreasing air pressure in the Service Module. They had to conserve food and water. The astronauts had to get around the Moon. Both Modules, the Lunar and Command, needed to save fuel in order for them to land safely.

Due to the explosion, the navigation system was unreliable. The astronauts used the Sun as the navigation point to guide the crippled spacecraft to Earth. While enduring sleeplessness, the astronauts moved back into the Command Module, then ejected both the Lunar and Service Modules. After Earth's reentry, the astronaut landed in the Pacific Ocean almost four days after the explosion.

Apollo 14

After Apollo 13 failed its landing mission on the Moon, Apollo 14 attempted to land on the Fra Mauro landing site. The Apollo 14 crew, namely, Commander Alan Shepard Jr., and Lunar Module Pilot Edgar G. Mitchell performed space experiments different from those that were planned for the Apollo 13 experiment. The Command Module Pilot, Stuart Roosa rendezvoused with the Lunar Module after the lunar liftoff. The Modularized Equipment Transporter was added to improve the crew's ability to move around. The equipment is a light hand-drawn cart that enabled the crew to transport tools and samples with greater ease. Two moonwalks happened in this mission. The astronauts walked for 9 hours and 21 minutes. Toward the end of the moonwalk, Alan Shepard became the first astronaut to hit a golf ball on the Moon.

Apollo 15

The Apollo 15 mission was known as the first mission to explore the Moon over long periods, greater range, and more scientific instruments for the collection of scientific data than on previous Apollo missions. The lunar

roving vehicle (LRV) was worth U.S. $40,000,000. The LRV reached a top speed of 16 kilometers per hour (10 miles per hour) across the Moon's surface.

NASA reports that the successful Apollo 15 lunar landing mission was the first in the series of three advanced missions planned for the Apollo program. The primary scientific objectives were to observe the lunar surface, survey and sample material, and surface features in a pre-selected area of the Hadley-Apennine region, set up and activate surface experiments, and conduct in-flights experiments and photographic tasks from lunar orbit.

A total of three moonwalks occurred during Apollo 15 for a combined duration of 18 hours and 33 minutes. Commander David Scot and Lunar Module Pilot Irwin completed the first of the extended lunar scientific expeditions known as the J-series. Also, Apollo 15 televised the first lunar lift off and recorded a walk in deep space by Alfred Worden.

The scientific payload was double the previous Apollo missions.

Apollo 16

The Apollo 16 crew was Capt. John W. Young commander, Lt. Commander Thomas K. Mattingly II, CM pilot, and Lt. Colonel Charles M. Duke Jr., LM pilot. The number 16 is a coincidence of the Apollo 16 that was launched on the 16 th day of April 1972.

In this mission, a number of experiments were deployed ,and two impressive landmarks, Stone Mountain and the North Ray crater, were visited. Samples taken from the rim of North Ray crater later proved to be bedrock thrown up from the meteorite impact that had created it. Three moonwalks with lunar surface activities totaling 20 hours and 17 minutes were accomplished by Young and Duke. The Apollo 16 crew remained on the lunar surface for a total of about 71 hours. After lunar lift off, the Lunar Module rendezvoused with the Command Module (CM) and Mattingly II.

When the Apollo 16 crew returned to orbit, there was a technical problem. The crew was tense because a faulty engine on Casper, the Command Module, had to fire. The crew decided to take the module to the far side of the Moon where the burn would take place as Mission Control waited for news. As a result the burn had the desired effect as the crew re-established radio contact to ground Mission Control. Apollo 16 entry and landing proceeded as usual.

Apollo 17

Apollo 17 culminated man's active exploration of the Moon's surface. The intensive activity of the Apollo missions answered many questions about lunar science. However, many questions remain to be answered. Perhaps, in the future, unanswered questions will be answered after the data already returned has been analyzed. Some questions will have to wait for data yet to be returned from the scientific instruments already in place on the Moon's surface. There will still be other questions waiting for further missions or space explorations.

The basic objective of the Apollo 17 mission was to sample basin-rim highland material and investigate the geological evolutionary relationships between these two major units. Command Module Pilot Ronald Evans remained in lunar orbit aboard the command module, "America". Commander Eugene Cernan and Lunar Module pilot Harrison Schmitt, also a professional geologist, engaged in three moonwalks for a total of 22 hours and 2 minutes. The Lunar Rover also experienced its first lunar fender bender. (NASA 2005).

In summary, Project Apollo had six lunar manned missions. Twelve American astronauts landed on the Moon. They spent collectively about 300 hours on the Moon's surface and 80 hours of that outside the landing aircraft. The astronauts collected rock samples, photographs and set up experiments to monitor the Moon's activity and its environment. People from all over the world acknowledged the Apollo Program's successful missions.

The Apollo Program lasted for 11 years. There were half a million people and over 20,000 companies working together in a harmony unmatched in the twentieth century. It was the finest creation of a peace time civilization and it performed with unmatched success (Pyle 180). Buzz Aldrin summed up the Apollo missions and quoted, "We need to move from Magnificent Desolation to Magnificent Inspiration" (Pyle 2005).

Apollo Space Program Science

Space

Earth is surrounded with a blanket of air. This blanket of air is called the atmosphere. It provides oxygen to keep us alive. Atmosphere protects us from the heat of the Sun during the day and the cold during the night. When one moves away from the surface of the Earth, the air thins out and its composition and temperature change. It becomes increasingly difficult for a person to survive. The changes continue as the altitude increases and outer space approaches. The transition from Earth's atmosphere to outer Space is gradual; there is no obvious barrier to cross. Above 1,600 kilometers (1000 miles) from Earth's surface is considered outer space but many of the conditions usually associated with outer space are experienced by astronauts within a few hundred miles of Earth (Stott 10).

Gravity

When a ball is thrown into the air, it returns to the ground. Gravity is the reason for the ball's return. Earth has an unseen pulling power known as gravity. Our planet Earth is not the only planet with gravity. Objects, stars, planets and moons have gravity. In fact, anything with mass has a gravitational attraction. Gravity is the force of attraction between all objects and it is the force that pulls humans and objects to the ground because the Earth is so much larger than us. Otherwise, everything would fly out into space. The Sun's powerful gravity keeps Earth in orbit around it because it is so massive. Gravity also pulls stars and planets into round shape called spheres.

Isaac Newton (1687), a physicist and a mathematician made a remarkable discovery. He understood that the same force that causes an apple to fall to the ground also keeps the Moon in orbit around the Earth. According to Newton's universal law of gravitation, the more massive the object is, the more gravity it has. The closer two objects are, the stronger is the gravitational pull between them. So putting these two ideas together, the more massive and the closer two objects are, the greater the gravitational attraction between them.

Newton came up with three laws. The first law is that an object in motion in a straight line remains in motion, and an object at rest stays at rest. This is known as inertia. The second law is that if a force is applied to an object, then the object will experience an acceleration (a change in its motion) that is directly proportional to the force, and inversely proportional to the mass of the object. The third law is called action-reaction. For every force action there is an equal and opposite reaction force.

On Earth, our feet remain firmly on the ground, held there by the downward force of gravity. However, the further we separate ourselves from the surface of the Earth, the weaker the pull of gravity becomes. When an astronaut is in space, there is still a pull of gravity but because the spacecraft is in orbit the astronaut is actually falling in a circle around the Earth. This creates a centrifugal force which balances out the gravitational forces on the spacecraft and on the crewmember. If the spacecraft was not orbiting the Earth with enough velocity to balance out the pull of gravity, it would fall back down to Earth. If the spacecraft was going too fast, it would go flying out into space.

As a spacecraft orbits the Earth, the astronaut experiences a condition known as weightlessness because the astronaut is in freefall. For instance, if astronauts could somehow step on a normal bathroom scale in space (although they could not do this without tying themselves down), the scale would read zero. That is because the scale is falling at the same speed as the astronaut. Because of weightlessness, many actions that are impossible on Earth become possible in space. The astronauts in the Space Shuttle when in orbit cannot feel gravity working on them, but it is there. Their spacecraft is constantly being pulled by Earth's gravity. Actually the spacecraft is resisting the pull and stays in orbit by attempting to travel away from its orbit.

Sir Isaac Newton's first law is if something is not moving it will stay where it is. For example if an astronaut working outside the Shuttle loses grip of his or her tool and gives it a little nudge, it will keep going until something stops the tool. Therefore, an astronaut working outside the Shuttle must use a cable to secure him or herself. Astronauts have to be careful not to float into space!

Getting into space is very challenging. The distance from the Earth to the Moon is 386,224 kilometers (240,000 miles). That is far. The first thousand kilometers is the most crucial part in space travel because the spacecraft has to escape Earth's gravity. In order to do that a rocket is needed. Sir Isaac Newton's third law states that for every action there is an equal and opposite reaction. This is how a rocket works. It propels extremely hot gases out of the spacecraft's bottom where a nozzle is located, which causes an equal force that lifts the spacecraft into space.

This is also the result of conservation of momentum. This states that momentum, which is the mass times the velocity, is always conserved. The momentum of the gas exiting the rocket must be equal to the momentum imparted to the rocket. This seems hard to believe because the mass of the gas is so little, however, it is moving at an incredible speed. Therefore, the momentum of the gas is equal to the change in momentum of the rocket.

Imagine yourself traveling on a 737 Boeing plane from Houston, Texas to New York City, New York. The airplane trip is 2281 kilometers (1418 miles). Because the plane's speed is 930 kilometers per hour (578 miles per hour), it takes you about 3 hours flying time. That is slow in terms of space travel. To escape from Earth you must travel very fast to the speed of 40,000 kilometers per hour (25,000 miles per hour). Escape velocity is the critical speed. If a rocket, a spaceship, and an astronaut is slower than the escape velocity they would all fall back to Earth. A rocket or a spacecraft is able to leave Earth's gravity because unlike a stone that is pulled back to Earth, the rocket achieves escape velocity which is the speed that it takes to go beyond the force of gravity and get into outer space.

The Apollo Space Program and many future Space programs will continue to send humans (astronauts) into space. There was a time when some people were skeptical whether humans or any living thing would survive in space. We have learned that most of the astronauts in the Apollo program survived with the proper protection and technology. NASA states that the United States Skylab Program, the Russian's Salyut, and Mir Programs have demonstrated that humans can survive space flights of several months to a year. Sunita

Williams from Massachusetts completed a total of 194 day in space on June 21, 2007. Although it was her first flight, she became a record holder. Astronaut Sunita Williams completed 4 space walks during Expedition 14 with a total of 29 hours and 17 minutes. She survived and returned safely to Earth.

On the other hand, human survival is not the same as living or working in space. The questions of how long can humans live in space and can they work in space are very complicated to answer. Answers to these questions require sophisticated scientific experimentation in order to comprehend just how the human body changes during voyages into space.

There are three main differences between Earth and the space environment that challenges human survival. First, there is no atmosphere in space. Earth's atmosphere is made up of gas mixtures necessary to support human life. When we breathe or inhale, gases are drawn into our lungs. Oxygen is absorbed into our blood stream and carried to the cells and used to fuel the countless actions our body performs every second. Meanwhile, we expel carbon dioxide every time we exhale. The breathing process is essential to all humans, and this is why we depend on the correct mixture of gases to sustain our life.

In the spacecraft cabin and astronaut suits, the temperature must also be regulated and controlled because space is subject to extreme temperature variation. Open space is extremely cold. Temperature measures energy and there is nothing in open space that can absorb the energy from the Sun and radiate heat. The Sun's energy passes freely through space. On the other hand, when there is a mass present, for instance the Earth, the planets, or a spacecraft, the mass will absorb the energy from the Sun and this energy becomes heat. A spacecraft or an astronaut outside of the spacecraft performing an activity which is called the EVA (Extra -Vehicular Activity) lying in the Sun's path could absorb the direct heat from the Sun and become extremely hot. Hence, the spacecraft or the astronaut in his or her spacesuit must be protected from overheating (or freezing) through the use of insulating material. Therefore, the spacecraft and the spacesuit must regulate the temperature of the heat and the cold so that humans can survive in space.

The next main difference is that space does not have an atmospheric filter to help shield and protect humans from exposure to harmful radiation. Some radiation is harmful to the human body. The Earth's atmosphere filters most of the Sun's ultraviolet rays. The atmospheric shield protects us from the worst effects of the Sun's radiation. It is a fact that overexposure to the Sun will lead to skin cancer. However, if there was no protection from the Sun's radiation in the atmosphere at all, humans would not survive.

The last main affect on human survival in space would be the absence of gravity in an orbiting spacecraft or object. The term weightlessness is associated with the word zero gravity. However, weightlessness in orbit is not because there is no gravity. Weightlessness happens when a body or an object is : falling freely; in orbit; in outer space (far from a planet, star or massive body); in an airplane following a particular parabolic flight. When an object is in orbit, it travels at a rate that escapes the pull of gravity thus causing weightlessness. An example of weightlessness is crewmembers that can turn somersaults with ease as they float in space. Weightlessness also causes objects like tools to drift dangerously about in a space cabin. These tools should be fastened securely with a material like Velcro. One must remember that gravity can never be eliminated. That is why it is not right to call weightlessness as "zero-g". Microgravity is the correct term. Since the level of gravity is so small in an orbiting spacecraft only the most sensitive instruments are capable of measuring it.

Microgravity is a new experience for the human body and all the mechanisms that have evolved to cope with the constant tug of Earth's gravity called "1-g" no longer function in the same way in space. But as long as a spacecraft contains a carefully controlled atmosphere to enable normal breathing, adequate temperature regulation, and adequate shielding to guard against the dangerous radiation levels, the human beings can

survive under microgravity conditions (NASA V 6.0).

An important objective of NASA is to support human's exploration of outer space. The success of human exploration depends on the health and the well being of the astronauts that travel there. One of the astronaut's problems after space travel is the musculoskeletal system. Laboratory rats were used in NASA's previous experiments. The scientists discovered that laboratory rats showed that certain leg muscles lost 40%of their mass after being exposed to microgravity. After studying humans from space flights, findings show that astronauts have a loss of muscle mass after months in space regardless of an extremely active exercise program.

Our skeletal system serves as both the framework for the body itself and the support system to maintain its normal posture. But weightlessness causes a slow loss of bone minerals. Astronauts from previous space flights have shown continuous loss of calcium which is an important component of human bones.

How to Become an Astronaut

The word astronaut is derived from the Greek words *astron* and *nautes*. It means "star sailor". In the year 1959 there were only seven astronauts in the whole country. Most of them were in the U.S. Armed Forces. Forty eight years later much has changed. Nowadays, the Shuttle crews consist of American citizens from every race, creed color and gender. NASA's informs us that as of May 1993, there were 180 Caucasian men, and 21 women, 6 African American men and one woman, and two Asian American men in the astronaut corp.

Many people apply to be an astronaut. NASA chooses astronauts from a diverse pool of applicants from all over the world. Every two years 100 men and women are chosen for an intensive astronaut training program. A master or a doctoral degree is one of NASA requirements, and a college degree from an accredited institution is the minimum requirement. An astronaut applicant must be proficient in his/her oral and written skills, know history and must be bilingual (Russian preferably). Astronauts get paid like other career professionals. The government has a salary scale called the GS scale. New astronauts receive U.S. $45,000.00 per year. Experienced astronauts get U.S. $52,000 to $80,000 per year. In addition they received the following benefits: health insurance, paid vacation, and retirement. Astronauts work from the classroom to the spacecraft. They work from 60 to 70 hours a week on normal days, but about 100 or more hours on spaceflights. Astronauts who are found to be claustrophobic will not be able to continue with the program.

Astronauts go through extensively rigorous training before a mission or a spaceflight. They are trained how to perform jobs in a space environment. The condition of weightlessness is practiced by scuba training or by using a special harness to get used to free floating. Astronauts are trained how to work under stress and in emergency situations. They go through simulators that move them in all directions except up and down. Moonwalk is simulated. They are told to wear a bulky spacesuit for the Moon. Astronauts practice how to hop which is the best way to move on the Moon's surface. The moonwalker suspended chair helps astronauts practice walking forward in small steps. A multi-axis wheel that looks like an astronaut's cage simulates the increase of gravitational forces which they experience by being spun in a centrifuge machine.

The astronauts have to be prepared for weightlessness. The simulator called Five Degrees of Freedom (FDF) allows astronauts to move in all directions except moving up and down. The astronauts experience 20-30

seconds of weightlessness. Sometimes they practice weightlessness on a KC-135 jet aircraft. This jet dives from 10,000 meters (35,000 feet) to 7,315 meters (24,000 feet). The weightlessness experience takes only a brief time but it is repeated many times a day. Astronauts who are selected to be pilots train for the extravehicular activity (EVA). They are trained in a huge water tank. This simulates weightlessness and the sensation of gravity is reduced. Only successfully trained astronauts get assigned to a spaceflight.

Spacesuit

An astronaut for protection wears a space suit. It protects the astronaut from the extreme heat or extreme cold. The temperature outside the spacecraft is 250 F in direct Sun and a freezing -250 F in shade. Spacesuits must be fail- safe, tough, durable and made up of high technology materials, and they must be flexible so that the astronauts can move about freely in weightlessness. The astronaut wears an inner head gear called the "Snoopy Cap". This is where the communication gear is attached. An astronaut's visor is Sun proof. It reflects the intense light from the Sun. The drinking bag is found at the bottom of the helmet. Lights are on the side. They enable an astronaut to see when they are on the dark side of the Earth. The astronaut's suit protects him/her also from micro-meteoroids. The suit contains a survival kit good for eight hours with oxygen, batteries, and food. The upper part of the astronaut's suit is made of a fiberglass shell. Inside the suit is a device used for passing water from the body. It is called a urine connection device. There is a urine connection device and they have a special adult diaper used during space travel. The lower part of the astronaut's spacesuit is like a layered cake. It consists of Dacron-polyester, nylon, aluminized Mylar and Ortho fabric. Also, Kevlar is an excellent material that is woven in it. Another material that goes with the spacesuit is the spandex mesh. There is a liquid cooling garment under the suit.

How Astronauts Live in Space

Astronauts live in space just like the way they live on Earth. They breathe, eat, drink, sleep, maintain cleanliness, stay fit and healthy, and use the toilet. Weightlessness is the great difference. They do these activities differently. Astronauts use oxygen to breathe. That is why they have a fresh supply of oxygen circulating through the spacecraft. When the astronauts breathe, water vapor is collected. The water vapor is recycled and used in space experiments as well as for drinking. In space travel astronauts do not flush the toilet. Air is used to suck body wastes.

Astronauts eat three meals a day. Food is prepared for the astronauts before going to space. They eat food that is similar to Earth food. An oven is provided in the spacecraft. No refrigeration is needed for astronaut's food. Astronauts use utensils to eat their food and they have a tiny pair of scissors to cut their food packets. Their food is preserved to prevent bacteria from growing. They eat granola bars and nuts. Other foods are dehydrated such as macaroni and cheese, and eggs. Water is added to soften up their food. Fruits, yogurts and some meats are treated too. Apricots and peaches are partially dehydrated. Radiation is used to kill the bacteria from steak and other meats. Astronauts have to eat a lot of food rich in calcium to minimize bone loss. Dangerous food like bread crumbs are not included in astronauts' diet because they could get sick from breathing the bread crumbs floating around their cabin. Also, there are no hot meals because if the floating hot food touches an astronaut, it could burn him/her. Ketchup, mustard and mayonnaise are available for astronauts. Salt and pepper are liquefied to prevent them from floating away because, like the bread crumbs, they could be dangerous. Food packages are disposed in a trash compactor inside the spacecraft. High technology in food packing prevents food from floating away, is easy to use, and is designed flexibly so that it can be squeezed.

Astronauts have to sleep, too. They can sleep on their seats, in sleeping bags, on bunks, or by attaching

themselves to the orbiter wall. Weightlessness causes them to sleep vertically or horizontally comfortably. When astronauts sleep on their sleeping bags, they zip up themselves leaving their arms outside. They fasten themselves with straps on their waists. Reading lights are available at each compartment. There are also side panels that can be shut for privacy. When astronauts want to muffle the noise and reduce cabin lights, they use eyeshades and earmuffs. However, one or two of the crew members wear communication gear at all times for ground communication.

When astronauts finish their work at the end of the day, there are many activities for them to do. Some use their laptops to write e-mails and keep in touch with families. They also eat snack and drink soda which are in sealed packs or tubes. Soda cans have mouthpieces that allow the drink to flow out freely. Astronauts listen to music on CDs at low volume because the other astronauts are still working. They like taking pictures and videos to record their space flight. Astronauts do not do laundry or wash their hair on short space trips. Dirty clothes are bagged and brought home. Shampoo wipes are used to clean hair.

Objectives

My curriculum unit will illustrate the history of the manned missions of the Apollo Space Program and the science of space. This unit is written for English as a Second Language (ESL) 5 th Grade class in Science. I will integrate Reading and Science in my English as a Second Language class. The curriculum unit could be modified for students in mainstreamed classes. The unit will take about three weeks, during which I will be teaching them ESL Science forty five (45) minutes each day. The Houston Independent School District Curriculum Department provides relevant and aligned curricula, academic and instructional leadership, and professional development opportunities to support teachers, administrators and parents in the delivery of effective instruction which enhances learning and improves achievement for all students. The horizontal curriculum alignment matrix presents the first nine weeks through the fourth nine weekly lesson plans, whereas the vertical alignment matrix shows all grade levels lesson objectives. My curriculum unit will be aligned to my school district's mission statement.

My lessons will be on the Apollo Space Program history and the science involved in space travel. I will explain the background, spacecraft, astronauts, the missions, the Apollo Program applications to future space travels, the end of the program and its lasting influences. This unit will use trade books for the literature connection. The first literature connection will be the Space Exploration, written by Michael George, which describes mankind's dream of escaping the boundaries of Earth to explore the mysteries of outer space The next book will be Team Moon: How 400,000 People landed Apollo 11 on the Moon, written by Catherine Thimmesh. This book describes how 3 men went to the Moon. Two of the men walked on the lunar surface for the first time in Space History. There were teams of scientists and engineers that made that successful trip to the Moon possible. They would have filled ten baseball fields. The third book is Ellen Ochoa: The first Hispanic Woman Astronaut (Great Hispanics of Our Time) written by Maritza Romero. This story is about Ellen who was born in Los Angeles, California. She is of Hispanic descent. Ellen wanted to be an astronaut and became one.

This unit will encourage some students and their families to visit educational places like the Johnson Space Center in Houston, Texas. The trip will allow them to see NASA's Space exhibit of the Apollo Space Program, the modernization of the astronauts' spacesuit, and the different science experiments on the specimens that were collected from the lunar surface. They will also have the opportunity to see the old and the new Mission

Controls. This curriculum unit will encourage students to be future mathematicians, scientists and historians. The Johnson Space Center will provide students the chance to see some packaged astronauts food. The advanced technology that NASA scientists used in the Apollo Space Program will be seen by the students. When students have the opportunity to see the actual Project Apollo technology used by NASA scientists and the astronauts, learning will be meaningful and effective. ESL will be integrated with science which is the content area. My ESL students will be able to understand how the manned missions of Project Apollo contributed to mankind's generation of space travels. My ESL students will be proud to see how American scientists, astronauts and other people in NASA succeeded in reaching the lunar surface. That fulfilled the American dream of reaching the Moon.

Strategies

To teach this unit, I will create a visual timeline of the goals, astronaut heroes, and outcomes of select missions. I will use nonfiction literature as the springboard of my lessons on the technology and science of the Apollo Space Program. I will use the "5 E's" to teach my unit. Students will be engaged, will explore the Apollo Space Program history, will be able to explain the manned missions' history, will extend their understanding and will evaluate what they have learned about the unit. I will use differentiated instruction strategies because the ESL students are in different English proficiency levels. These levels are beginners, intermediate, advanced and advanced high. That means they will be divided according to their proficiency level. I will teach my ESL students how to work on reading, writing, science and math stations while I work with one level. First I will teach the beginning ESL students and the rest of the group will work on their assigned stations. I will rotate the groups. I will integrate vocabulary words in science and reading.

My ESL students like doing puzzle search. That is why I will create daily science vocabulary word puzzles for this unit. The puzzle search will take about 5-10 minute of class time. This strategy will be applicable to my ESL students in the intermediate and advanced level. This will also include the vocabulary chart that will enhance both reading, and writing skills. Another strategy is to let the students choose their favorite vocabulary words and create a chant or a poem. In order to do that I will first model the activity and do it for the whole class. Beginner ESL students will need help. Therefore, I will group my class heterogeneously for this activity, and then I will assist the beginning students more than the other groups.

I will teach the students how to use word cognates in Spanish and in English. I will use the verbal visual word association. I will divide a piece of note book paper into 4 parts. The first part will be the vocabulary term, the second part will be the personal association, the third part will be the definition of the science word and the last part will be a non-example of the vocabulary word. On a piece of paper, students will write the vocabulary term. The word cognates will also be used for space poems. Students will match the Spanish poems with English

Another ESL strategy that I will use is the window-paning strategy. The students will divide a piece of notebook paper into 9 parts. Each part will contain a vocabulary word. For example, I will select 9 vocabulary words (Space, Earth, Sun, Moon, orbit, speed, velocity, and Space Shuttle).The students will write the word on each box, draw and color the illustration of each vocabulary word. I will use the language experience approach to introduce vocabulary, dictate a paragraph from the non fiction book, write my ESL students responses on a chart, read and write about the newly created text.

A good ESL teaching strategy is the CLOZE procedure. I will give the students a reading passage about an astronaut for instance with 275 to 300 words. I will keep the first sentence intact. I will select a word in the second sentence to omit and replace it with a fifteen space blank. Then, I will omit every fifth word in the passage. ESL students will work independently. I will use the causality strategy by asking questions. For example "Why did President Kennedy send the astronauts to the Moon"?

I will introduce students to the concept of the rocket power with a simple outdoor experiment. My ESL students will work in groups of four. I will ask one group to describe what happened while the other groups perform the experiment. Students will discover that as they throw one object, they will begin to move backward. They will move faster when students throw the second object. For those students who throw both objects at the same time will experience one thrust. Explain to them that this is similar to the way rockets work Also explain to them that rockets that launch spacecrafts are made of different stages. After the explanation ask volunteers to repeat their discovery (science talk). On chart paper, ask each group to write down the concept of rocket power.

The students in the advanced and advanced high levels will pretend that they are astronauts. They will have an imaginary space mission and will write a diary of their space travel. One of my activities will be an Apollo Astronauts fashion show. Students will work in groups to research the different space suit designs used during the manned missions. Upon completion of their research they will create the space suits made of craft paper that were used by the different astronauts.

Another fun activity for writing is Book Beginnings. Explain to the students that "If you were an astronaut. . ." is a sentence starter. They will change the pronoun I to you, for a class book. First have the students copy the sentence starter from the board or overhead. Next, have the students complete the sentence by writing or dictating their thoughts. When the students have completed their sentences correctly, have them copy the words on construction paper and illustrate. Collate the pages to make a class book.

Classroom Activities Space/Literature

Part I. Space Exploration by Michael George

Objective: (Foundational Print Awareness): The students will develop a variety of foundation skills necessary for effective reading.

Procedure before Reading: Space Exploration takes us into the history of space travel. It gives the students the idea that people have always wanted to go into space and explore the Moon, the planets and the stars. Space travel is dangerous and difficult but in the beginning scientists used man made robots not men to explore space, from the Soviet Union's Sputnik 1, unmanned space probes to explore the Moon, the Apollo Space Program, the Space Station (Skylab) to the fascinating Planetary Probes. Before reading invite the students to share what they know about space. What do they wonder about? Record children's responses on a K-W-L (Things We *Know*, Things We *Want* to Know and Things I *Learned)* chart.

Activities: We Wonder. Challenge the student to think about what they read with these questions:

- What is an atmosphere? Describe the different layers of the Earth's atmosphere.

- Why were robots sent to space first?
- What is zero *g?*
- How did scientists, engineers and medical specialists enable people to survive in space?

Math Activity: How fast? How far? If a Shuttle travels around the Earth every 90 minutes at the speed of 28,000 kmh (17,500 mph), how far do you think you could travel by bike in 90 minutes? How far do you think you could travel by car in 90 minutes? What is the fastest way you have ever traveled? How far is your grandparent's house from your house? If your grandparents live in another state, how far would that be from your house? Calculate the distance with the students. How many times would you have to visit your grandparents to equal a trip around Earth?

Assessment: Teacher made test to check comprehension and vocabulary skills. Solve math problems similar to the math activity (see above).

Part II. Team Moon How 400,000 People Landed Apollo 11 on the Moon by Catherine Thimmesh

Objective: ELA.5.2.07 Students will identify expository text studies (problem/solution, chronology, comparison and contrast, cause/effect,) print features, graphic aids and organizational aids, in non fiction, to discuss how they influence the scope and depth of a text and to locate, organize and recall information.

Procedure before Reading: Team Moon gives students a rare perspective for Apollo 11 the first Moon landing story that involves many people not only the few and famous. Some of these people are the seamstresses who put together 22 layers of fabric for the astronauts' spacesuits. The engineers created a special heat shield to protect the capsule during its fiery reentry to the Earth's atmosphere. The story includes the flight directors, camera designers, software experts, suit testers, aerospace technicians, photo developers, engineers and navigators.

Activities: Vocabulary - Word Round-Up. Before sharing the book with the class, read through the text and make a list of all the space inspired words. Add the words to the vocabulary list and ask the students to use the dictionary to define each word. Give each student a paper plate. Divide the paper plate into four equal parts. Tell each student to write the vocabulary word on the first part. Next, write the meaning of the word. Then, draw and color a picture for the word. Lastly, tell the student to use the vocabulary word in a complete sentence. Another interesting activity is Writing: Into Orbit. Simulate Space launch. Have the students close their eyes as you (teacher) describe the journey of Apollo 11.

Assessment: Teacher made vocabulary test (match the word to the right meaning).

The other writing assessment is to pretend that you are one of the seamstresses of the Apollo 11 spacesuit. Draw the spacesuit; explain what it looks like and how it is made.

Part III Ellen Ochoa: The First Hispanic Woman Astronaut (Great Hispanics of Our Time)

Objective: ELA.5.2.07 Students will identify expository text studies print features, graphic aids and organizational aids, in non fiction, to discuss how they influence the scope and depth of a text and to locate, organize and recall information. To help students comprehend an informational text.

Procedure before Reading: Ellen Ochoa is one of the many great Americans of Hispanic descent that has contributed to the science of space. Ellen's mother instilled in her the value of education. Her mother taught her that education could help her become whatever she wanted to be. She learned that success comes from

being a hard worker. Hard work is one of the qualities of a good astronaut. Ellen Ochoa worked first as a researcher for NASA and is a licensed pilot. She lives with her husband in Houston, Texas.

Activities: Main ideas and Details. Explain that finding ideas and details is a good way to organize information about a topic. Ask what main ideas about Ellen Ochoa might be in the beginning section. Teacher records responses on chart paper. Read each section and continue to ask the students what main ideas might be in each section. Teacher records students' responses on a chart. Tell the students to write any words or ideas that they need to clarify.

Assessment. Teacher made comprehension check test or ask the children to write Ellen Ochoa a note giving a brief description telling why they like her story. Group assessment. Tell each group to dramatize the mother and daughter inspiring relationship. Ask each group to work together and create their own reader's theater. The script must be based on the group's favorite section.

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http://www.nasm.si.edu/collections/imagery/apollo/saturnV.htm This website provides the Apollo Program's Saturn V Launch Vehicle.

http://Space place.nasa.gov/en/kids/spinoffs2.shtml The interesting and comprehensible website provides the technologies and materials that were originally developed for the Space programs.

http://Space place.nasa.gov/en/kids/amazing_facts.shtml The amazing facts states cool stuff to know about Space, Earth and technology.

http://Space place.nasa.gov/en/kids/amazing_facts.shtml The website tells us about Prof. Starrs Dream Trip or how a little technology goes a long way.

http://Space place.nasa.gov/en/kids/projects.shtml The website provides amazing science and technology projects delightful for kids.

http://Space place.nasa.gov/en/kids/live/index.shtml The website shows two kids Kate and Carlos hosting their own show. They invite guest scientists who work on really cool Space and earth mission.

http://Space place.nasa.gov/en/kids/cs_Space _tech.shtml The website provides information on Space technology for example a slinky. It is a simple old fashion toy. On could use a straightened out Slinky used as a mast to support solar sails on a spacecraft.

http://Space place.nasa.gov/en/kids/friends_share.shtml The website invites people to join local community organizations. One of these organizations is the Astronomy Club Partner Program. The Space Place partners up with NASA to bring news of specific NASA projects to their members.

Appendix

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