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The Greening of Mars: The Changes Necessary to Sustain Life on Mars

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The purpose of this unit, entitled The Greening of Mars: The Changes Necessary to Sustain Life on Mars is to help children develop plausible mechanisms with which to change the red planet from its now uninhabitable state to a planet that could support life and fauna as we know it and to maintain a clean and healthy environment, that being a balanced ecosystem. It is designed for 5th grade students. The unit is divided into 6 sections for instruction—pesticides, ecology, recycling, gardening, Biosphere 2 and the preparation of Mars for habitation. The intent of the first 5 sections is to make children aware of problems that exist on our planet and how the solutions are relevant to maintaining a balanced ecosystem on a newly inhabited planet. They are not complete units in themselves, but can be elaborated upon with the teacher resource material listed at the end of this paper. Elaborating on these concepts, this unit would take from September to June.

Introduction

We began with a massive area of land. A country of phenomenal beauty. A country that housed mountain ranges, coastal plains, forests, deserts, different soils, a proliferation of water and a variety of climates and scenery. All of this guaranteed the inhabitants of our country a wide assortment of food, vegetation and wildlife. This great generosity was eventually abused by politicians, urbanization, industrialization and the everyday greed and carelessness of everyday man. Our land, our air and our water became the target of pollution. Illness, although not always obvious, was the end result in the young, the middle-aged and the elderly alike.

We must provide our younger population with all the knowledge that we can so that they might be qualified and confident to tackle the ecological problems that they may encounter in the future. It is highly relevant that there exists in man an intellectual understanding of our ecosystem and how the diversity of life is maintained. The world is a collection of relevant parts. To know what it is and how it functions is important. There is a biogeochemical cycle constantly functioning. These parts must be kept in harmony in order to be productive and function to their maximum potential. A clear understanding is necessary in order to create a situation on Mars that can be sustained by humans and other life forms. It is important to look back to the past and realize how and why we have created the world that we now inhabit. A world that is saturated by pollution and environmental problems.

If given the chance, could we start over and learn from our past? Could we, as an intelligent community, take the intent of Earth Day 1970 and let it design a living situation that would sustain life on Mars and also sustain a healthy and naturally balanced ecosystem? Can our youth, that we are leaving our experiences to, do the same? Can there be economic advances without destruction? If we can show our children how such action warrants pride in preservation, then maybe we will have some honest and legitimate hope for the future.

Why not start from scratch? Take a land that is presently uninhabited, such as Mars, and establish a settlement. Hopefully, we would have learned from our past and how we have contaminated our world. We should look toward preservation by conservation. As a precursor to actually settling Mars, one must fully comprehend the relationship between organisms and their environment. One must understand ecological principles in order to understand ecological problems. This will be achieved in a way that young minds will be stimulated. It will include three units that will run concurrently. These units will cover pesticides, ecology and recycling. They will be followed by a unit in gardening and Biosphere 2.

Pesticides

Students will be listening to actual case studies that expose a plethora of poisons that people and animals are living with. It will be demonstrated how air, water and soil pollution occur through the carelessness, ignorance and lack of moral ethics of man by readings from Quick Poisons, Slow Poisons: Pesticide Risk in the Lucky Country by Kate Short. These readings will make the children aware of the people and animals who have died, become violently ill, or who have suffered physically over a long period of time. The children will learn that chemicals can be airborne, absorbed by the skin or ingested as vapors through oral and nasal passages. The case studies are short and comprehensible. Many involve children and how they have been affected by pesticides through spraying and other means of contact. Students identify with these stories because they have seen playgrounds, classrooms and their homes being sprayed. (1)

Rachel Carson, writer and biologist, is regarded as being responsible for setting forth the environmental movement through the publication of her book, Silent Spring. After raising the awareness of people around the world a heartfelt concern was manifested for the future of our planet Earth. This landmark publication raised the consciousness of people that led to the banning of DDT and changes in laws that would affect how our land, air and water would be cared for. Rachel Carson brought it out in the open how spraying pesticides has harmful effects on insects, weeds and threatens the lives of other creatures. She demonstrated the effects that spraying has on the food chain. The town of Silver Spring was so impressed with her findings that they decided to vote against using pesticides to kill mosquitoes. (2) The new generation, entering the world and the power that they can administer in changing laws and enforcing those laws, should be made aware of just what Rachel Carson accomplished. They, as inhabitants of this planet, should continue to carry her message. The following article and two activities bring the message of Rachel Carson across to the young through comprehension and writing exercises.

For many years, many insects, weeds, and other kinds of pests created problems for people. Farmers had problems with insects destroying their crops. People complained about annoying insects. Railroad workers were disturbed by weeds growing around the tracks. Fruit growers were troubled by caterpillars that ate their fruit. These concerns led scientists to search for a solution. During World War II, they produced pesticides. Pesticides are poisonous chemicals that are used to kill unwanted insects, plants, and fungus. The most common pesticide was dichloro-diphenyl-trichloroethane, or DDT. Although pesticides helped to eliminate

many problems, others were created. Rachel Carson, a well-known scientist, was determined to explain the consequences of using pesticides.

Harmful Effects

Rachel Carson had many lessons to teach people about the harmful effects of spraying pesticides. In 1959, she attended a community meeting held in Silver Spring, Maryland. They were deciding whether or not to spray a pesticide to eliminate annoying insects. Rachel Carson listened to their arguments for and against pesticides. Finally, she spoke about the dangers of pesticides. She said that pesticides not only destroyed the insects, weeds, or fungus being sprayed, but they also threatened the lives of other creatures. For instance, when bushes or trees are sprayed with these poisonous chemicals, birds, bees, and other creatures can die. In addition, people who go near these sprayed areas are harmed by the poisonous chemicals in the air. Furthermore, these chemicals are dangerous to animals that are near areas that have been sprayed. Pesticides can destroy all living things.

Natural Food Chain

Carson further revealed the unhealthy effects that spraying pesticides had by examining the natural food chain that exists among all living things. This is a sequence by which smaller animals and plants are eaten by larger, stronger animals that are then eaten by even stronger animals. For example, plankton are tiny plants and animals that live near the ocean's surface. They become poisoned when pesticides land on them. Insects eat many poisoned plankton. Therefore, they become poisoned. These insects become food for small fish. Since these fish devour, or eat, many poisoned insects, they have large amounts of pesticides inside their bodies. Larger fish and animals eat the smaller poisonous fish. Large doses of poisons enter their bodies and stay there for life. Then, people eat these large fish or animals that were poisoned by the pesticides. In addition, people eat fruits and vegetables that have been sprayed with pesticides. Even though fish, fruits, and vegetables contain small amounts of pesticides, these chemicals build up inside the body. They reach dangerous levels and harm people's health.

The Vote

After listening to Carson's speech, the people voted against using pesticides. Carson taught them that living things are linked to each other and their environment. Also, she taught them that it is not wise to use chemicals to control the environment. Pesticides are dangerous to wildlife and people. (3)

Cloze Exercise

Read the passage. Choose the best word to fill in the blank. The word you choose must make sense in the whole passage.

Rachel Carson was born on May 27, 1907. She lived with her family on a farm. At an early age, Rachel Carson was surrounded by 1 . She took care of the pigs, cows, and hens. She played with her family's cats, dogs, and rabbits. Her mother taught her about the birds, insects, and plants that were found in the forests near their house. She often walked through the 2 with her mother. Rachel Carson spent a great deal of time outdoors observing nature in fields, forests, and streams.

1. a. toys b. buildings c. friends d. animals e. fields
2. a. store b. library c. woods d. storms e. desert

When war broke out between the United States and Germany in 1917, her brother joined the United States

Army Aviation Service. Although Rachel Carson was only ten years old, she was concerned about the fighting going on in Europe. She listened to news about the war. In addition, her brother shared stories about the war with her. Fascinated with his tales, Carson wrote her own story about the war. She sent it to a children's magazine. The magazine editors enjoyed her story. Therefore, they 3 it. Rachel Carson continued to write other stories for other magazines.

3. a. returned b. wrote c. found d. lost e. printed

After high school, Rachel Carson went to college. During her first year of college, she wrote stories about the sea. Even though Rachel Carson had never seen the ocean before, she had always been curious about it. She had read many books about sea life throughout her childhood. However, she 4 got to see the ocean. At twenty-two, she saw the ocean for the first time when she traveled to Cape Cod, Massachusetts, to study sea life.

4. a. never b. only c. always d. often e. once

In her second year of college, she took her first biology class. Carson enjoyed studying how nature works. Carson had 5 to be a writer. After taking this course, she changed her mind. Instead of becoming a writer, she studied to become a scientist. When she graduated, she continued to study sea life at Johns Hopkins University. After graduation, Carson got a job writing scripts for a radio show about ocean life. Now she did not have to make a 6 . This job combined her interests in the sea and writing.

5. a. planned b. hated c. pretended d. traveled e. fought

6. a. cake b. date c. choice d. sale e. trip

Throughout Carson's career, she wrote magazine articles and books. She wrote several best-sellers. Her books were 7 . Silent Spring, her last book, made her well-known. Rachel Carson had written many books describing the beauty of nature. However, the last one was written to warn people about the dangers of pesticides to nature and people. Rachel Carson devoted her life to her work. She taught people to protect their environment. She died of cancer on April 14, 1964, shortly after her last book was written.

7. a. strange b. old c. destroyed d. small e. popular (4)

Use the following for writing exercises.

Radio Writing

Rachel Carson taught people that spraying can have negative consequences on nature and people. Write a public service announcement for radio warning people against the many dangers of spraying pesticides. Present it to your class.

Play Writing

Rachel Carson attended a meeting in 1959 in Silver Spring, Maryland. The people in that community met to decide whether to spray pesticides to get rid of mosquitoes or not. Some argued for spraying while others argued against. Then, Rachel Carson spoke out on the dangers of spraying pesticides. Write a script about this meeting. Be sure to include the results from the vote made by the community. Your classmates can act it out.

Creative Writing

Rachel Carson explained the natural food chain to her audience at the meeting. A food chain is a sequence by which smaller animals and plants are eaten by larger, stronger animals that are then eaten by even stronger animals. Write and illustrate a cartoon showing a natural food chain. Be sure to include the name of each type of smaller plant of animal, the larger and stronger animal, and the largest and strongest animal. Also include how human beings fit into the food chain.

Summary Writing

Write a summary about the cloze passage you just read on the cloze exercise. (5)

Ecology

Ecology will be another unit. It will be conveyed that ecology is the study of the relationship between plants, animals and their environment. Related to our ecology is our ecosystem, that being a combination of all living things and things in a community and its nonliving or physical environment. Everything is interdependent on all living thngs as to what they need—that being water, oxygen, carbon dioxide, sun and food. It is relevant that one understands that there are producers: chestnut trees, vegetable plants, flowers, grass, berry bushes; consumers: lions, tigers, birds and whales; and decomposers: earthworms, bacteria and molds. Observing, recording, and evaluating can be employed so that children could arrive at a conclusion about a particular concept.

Do you remember making mud pies when you were small? You mixed soil and water together and shaped it with your hands. It took some practice to get the mud the proper consistency. If you used too much water it wouldn't hold together. Likewise, if you used too much soil it would be to dry. It was important to get the right proportions of soil and water to achieve the proper balance necessary to make a mud pie.

The Balance of Non-Living Things

In nature non-living things such as carbon-dioxide, nitrogen and water are used over and over again through their own cycle.

In the carbon dioxide-oxygen cycle living things take in oxygen and give off carbon dioxide. The carbon dioxide is absorbed by plants and oxygen is expelled when the plants manufacture their food. Plants take in carbon when they take in carbon dioxide and animals take in carbon when they eat the plants or other animals. When plants and animals die and decay the carbon is released through carbon dioxide and the cycle begins again.

In the nitrogen cycle the air is absorbed by soil and bacteria in the soil changes the nitrogen to nitrates. The nitrates are passed on to the plants and the plants are consumed by animals. When the plants and animals die and decay nitrogen again is released into the air to begin the cycle once again.

During the water cycle, water is heated by the sun and changes to water vapor. The water vapor rises into the atmosphere and forms clouds which eventually descends as rain and replenishes bodies of water and food supplies. Again the water evaporates and the water cycle begins again.

The balance of the above non-living things is necessary for the balance of living things. An activity that will help children understand the physical factors of an environment would be a drawing that they would make that would revolve around an animal of their choice.

Skills:

1. Applying learned knowledge.
2. Inference.
3. Categorizing living and non-living things.
4. Relating living things and non-living things to each other.

Prior to the children implementing this activity, you will:

1. Set the stage. Instruct them on the concepts to be taught.
    a. ecology is the study of living things and how they are interdependent on the environment around them.
    b. the physical factors of an environment are light, air, water, temperature, atmospheric gases and various land forms.
2. Elicit background.
    a. brainstorm with children about what they already know about different animals.
    b. have available books on a variety of animals that contain facts about where they live, how they live and how they survive.
3. Have materials available.
    a. 12x18 sheet of white drawing paper.
    b. crayons, markers, pencils.

Instruct children to:

1. Draw an animal of their choice on the paper.
2. Add in the terrain in which the animal lives—mountains, hills, forests, jungle, desert, polar regions, valley, plains, coastal areas, ocean, lake, river, etc.
3. Show where he gets his water.
4. Draw what he eats.

5. Show how he keeps his body at a comfortable temperature.
6. Illustrate the animal's camouflaging technique.
7. Draw around your animal the other animals that live with him.
8. Draw around your animal the plants, trees, or other types of ground cover that are around your animal.
9. Give an oral presentation about your animal explaining why all of the above are important.

The Balance of Living Things

Imagine if all the fish were killed in the uppermost part of the northern hemisphere because of a poison that infilltrated the habitat of the fish. What would happen to the bears and seals? They would eventually starve and could eventually be deemed as endangered. The food chain is another important part of our ecosystem and a chain that children can readily understand. The activity below demonstrates the manner in which our ecosystem functions and how animals are interdependent on each other.

Skills:

1. Thinking through questioning.

2. Retrieve previously learned knowledge.

3. Research skills.

4. Oral presentation.

Materials:

1. One wire clothing hanger.
2. About 6 pieces of various colored yarn, cut in 4-inch lengths for each student.
3. About 7 pieces of oak tag for each student cut in 4x5 in. rectangles.
4. Crayons, markers, colored pencils.
5. A hole puncher.

Procedure:

1. Have children punch a hole at the top and bottom of each rectangle on the 5 inch side.
2. Choose an animal and draw it on one of the pieces of oak tag.
3. Ask yourself, “What does my animal EAT?” and draw it on another piece of oak tag.
4. Continue this same line of thinking through questioning until you cannot go any further.
5. Take the very last card that you drew and attach a piece of yarn through the top hole, knot it and then attach it to the wire hanger to begin your mobile.
6. Looking at the first picture that you attached to the wire hanger, ask yourself, “Who needs that to eat?” Attach to the first card.
7. Continue until all cards are attached to each other.

Evaluation:

Choose a mobile and ask what would happen if the animal in the middle of the chain of cards was missing. What would be some reasons why this animal is missing? (Acceptable responses would be - flood, fire, pollution, other natural disasters, poisons, hunters, building of homes, malls, roads and destruction of forests for farmland.) Let children discuss what happens to the other animals in the food chain. (Acceptable responses - those closest to the hanger would increase in number, those below the animal would starve.) Ask children to think about what would happen if the water supply had a chemical in it that did not belong there and one animal drank the water. Ask them to think about how this poison could travel from one animal to another. A question for discussion - “Could we take in a poison and not know it?”

Recycling

The third unit to run concurrently with the above will be on recycling. Taking care of products above the ground is essential for a clean earth. Taking care of what we put into the ground and what eventually gets into our bodies is of the utmost importance. Through the years, because of industrialization and urbanization many “things” have been introduced into our ecosystem. Over a period of years our soil, water, food supply and wildlife have been affected by these “things.” They have saturated resources to the point of causing destruction, whether it be to our bodies or our environment. Before we could create a new balanced ecosystem on Mars, it is important to know how to conserve our natural resources and how to protect them. In order to prevent water, air and soil pollution, we must first understand how to reduce, recycle and reuse our waste. We must also eliminate our use of dangerous or toxic chemicals because there is no safe method of recycling or storing them.

The class will be involved in constructing two landfills. The objective will be to construct one of biodegradable material and the other of non-biodegradable materials.

Skills:

1. Comparing

2. Contrasting

3. Organizing

4. Categorizing

5. Predicting

6. Observing

7. Recording

8. Evaluating

9. Technical Writing

10. Narrative Writing

Materials:

1. 2 ten gallon aquariums.
2. 1 20 lb. bag of soil.
3. Several pieces of newspaper, metals, plastics, glass, styrofoam and cardboard.
4. Banana skins, vegetable pieces, peanuts, grass, twigs, dried leaves, flowers, and other biodegradable items.
5. 2 labels, permanent markers, small shovel, journal.

Procedure:

1. Put a label on each aquarium. Label the aquariums #1 plus the date and #2 plus the date.
2. In aquarium #1 put a 1-inch layer of soil.
3. Place a layer of newspaper pieces of top of soil.
4. Place a layer of soil on top of newspaper pieces.
5. Alternate layers of soil and items in non-biodegradable list until all are used.

6. Follow the same procedure for aquarium #2 using items from the biodegradable list.
7. Keep the soil damp by watering it gently when it becomes dry to the touch.
8. After a week gently stir the soil and materials in both aquariums.
9. Record the changes that you notice in your journal.

Record your observations in the following manner:

Aquarium #1	Aquarium #2
Week #1	Week #1
Color:	Color:
Texture:	Texture:
Size:	Size:
Odor:	Odor:
Other observations:	Other observations:

Continue making observations at one week intervals for several weeks.

Evaluation:

1. What did you observe about the materials in each landfill?
2. Which materials decayed?
3. Which materials did not decay?
4. What are the advantages of aquarium #2 landfill over the aquarium #1 landfill?
5. Which aquarium is a bio-degradable landfill?
6. What are some ways that we could eliminate storing our non-biodegradable trash in a landfill?

A comprehensive resource for lessons on reducing, reusing and recycling is entitled, Reduce, Reuse, Recycle by Sandra Ford Grove and Dr. Judi Hechtman and published by Creative Teaching Press, Inc. Cypress, CA, 1996. The lessons provide the teacher with a systematic approach to hands-on scientific explorations with meaning. Each lesson states the learning outcome, process skills, connections, materials, explorations and

conclusion. The materials used are things you find around the house.

In this unit, it is important to have feeling for the earth and regard it in much the same fashion as the American Native showed respect for their land by wearing moccasins. They felt that you must walk gently upon the earth so that it would not be injured. Creative writing is a good tool for children to become more involved in their lessons from a fun point of view. A good method to follow would be the one developed by Dr. Robert Paulker and demonstrated through his book, Thinking Through Questioning and The Organizer, Dr. Robert Paulker, Chester, CT 1996.

Dr. Paulker's formula employs the M6DF pattern. Have children write an essay in response to the following prompt. The essay should be composed of an introduction followed by three paragraphs and a conclusion. Each paragraph will have a main idea and consist of six sentences. Descriptive words in those sentences and the paragraph should end with an expressed feeling. To elaborate, sentences follow with who, where, what, why and how procedure. Give the following prompt. (6)

As a discarded piece of (peach, tomato, peanut, string, candy wrapper or any other item of their choosing), I have spent three weeks in the soil behind my house. It has been quite an unusual experience. Many interesting things have happened to me!

This essay should be entered into their writer's journal and presented to the class as an oral presentation. With such a variety of ideas and feelings, children will hopefully look upon trash from quite a different perspective.

These simple explorations will eventually be applicable on a more global scale. Learning to recycle, reuse and reduce trash and making it fun makes for a more motivated student. These practices will benefit the earth, or whatever other planet that we will live on, and also helps to maintain its health. Exploration and discovery will lead to quality learning.

Gardening

Gardening is not an easy task. . . It is hard work but can be relaxing at the same time. You are probably closer to nature while gardening than during any other activity. Working with the soil and having the land be productive for you personally can be a satisfying experience. It is also a subject that you will never know enough about. Most schools do not have the proper soil on their grounds or even a place to plant a garden. Many teachers do not have any experience in planting a garden of vegetables, treatment of soil and knowing different methods of gardening. There are many and there will continue to be more. It will suffice to teach children how to get the soil ready, how to make a garden plan and think about what should be planted. Somewhere around your school, there is a little patch of land around a home that is just laying there idle. Have your children write a letter to the tenant or landlord asking if they could plant a garden in the spring.

During the year they would plant in a Root Vue Farm (HSP) a radish, an onion, and a carrot seed. Because the Root Vue Farm has a plexiglass front they will be able to view the roots as they grow and also the available space between the roots. They should come to the conclusion that they could plant vegetables with short roots in between the long-rooted vegetables. This will demonstrate to them how you could produce more food in a specific area. If they plant the garden in the spring, they could research this method and see how

productive it is. John Jeavons' book, How To Grow More Vegetables is an excellent source for this project. It gives examples for multi-crop planting, companion planting, garden plans and also bed preparation. This is not a children's book, but it explains all the methods with visuals. (7) Hydroponic gardening is very interesting to children on all grade levels. Place a small tomato plant in a glass jar that is filled with a mixture of water and Miracle-Gro. Be sure that the first set of leaves, at the bottom, are not submersed in the water. Support the plant at the top so that it does not fall into the water. When the roots get strong and long enough the plant may go into the ground. You may also keep it growing hydroponically. When the class starts to prepare Mars for habitation, they will reflect on this activity.

Biosphere 2

Biosphere 2—a small earth. This is a fascinating project and hopefully will lead to a better understanding of the way in which the Earth works. Goethe once said, "Nothing happens in living nature that is not in relation to the whole." In scientific terms we call this the web of life. Biosphere 2 is the web of life that keeps the elements of the Earth in harmony and in balance with each other. It is located at the foothills of the Santa Catalina Mountains, at the edge of the Sonora Desert, just thirty miles north of Tucson, Arizona. The city of Oracle, Arizona, is proud to boast of such a dramatic piece of construction that covers the length of three football fields.

Located in Biosphere 2 are what scientists call five wild zones. There is a rain forest, an ocean, a desert, a savannah and a marsh. The biospherian candidates who live there have a small farm of their own to work at and study and they live in what is called a micro city. Housed in this glass structure is the web of life with its plants and animals, water, air and food.

To study Biosphere 2 is a project in itself but does lend itself to some interesting research for children and in the light of this project some valuable and applicable information that they will be able to use. Have children form groups of 4-5 members. Instruct them to choose some of the following questions to answer and present to the class.

1. What is the length, width, height and square footage of Biosphere 2?
2. Why is it considered to hold the web of life?
3. What makes up the web of life in Biosphere 2?
4. Explain the continuous cycle of water, carbon dioxide, oxygen, ammonia and nitrogen that moves through Biosphere 2.
5. Explain the cycle of food, consumers, and waste-matter that makes up the food web.
6. Explain how plants leave waste matter and the positive effects of this process.
7. Choose one of the environments and present a full description of the component parts (savannah, ocean, rain forest, marsh or desert).
8. What was the purpose of using glass walls and roof and how was this constructed?
9. When the heat expands inside the biosphere because of the intense heat of the sun, why doesn't Biosphere 2 "blow up"?
10. How does Biosphere 2 get its power?
11. How is the air kept clean? (soil-bed reactors)

12. Who lived in Biosphere 2? What were their fields of expertise? Where did they come from? What are they doing now? If you wanted to work in Biosphere 2, how would you go about applying for a position?
13. What is the mix of animals? Where do they live? What are they used for? Are animals born in Biosphere 2? What happens if one of them dies?
14. Why are most of the animals small? How do they fit into the food-web system?
15. Where are plants located? What are some of the things that plants provide?
16. Why is the hummingbird so especially important? What is its main job?
17. Why are herbs grown? What is one of their most important functions? (medicine)
18. What are the highest and lowest temperatures allowed in the biomes? How do they control these temperatures?
19. What are the dimensions of the rain forest, savannah, ocean, desert, marsh, lungs and the farm?
20. What is the volume, in cubic feet of the ocean water, fresh water, lungs and air?

There are a multitude of questions that could be researched. Give the children the freedom to include, expand upon or demonstrate in art form any material that they feel is relevant. An excellent resource is The Glass Ark, The Story of Biosphere 2, by Linnea Gentry and Karen Liptak and published by the Penguin Group, New York, New York, 1991. You can also write to Biosphere 2 Center, Highway 77 & Mile Marker 96.5, Oracle, AZ 85623. The telephone # is (800)828-2462; fax # is (520)896-6429. Using the computer, e-mail Veronica Gillen, at vgillenbio2.edu.

The Time Has Come

Now we are ready to settle Mars. Critical and creative thinking along with discussion will be the skills most used for this final segment of the unit. Learning how Mars developed and its characteristics will be researched. Some scientists believe that at the time of the great solar burst the planets developed. All catapulted out into space by this phenomenal explosion. They eventually settled into an orbit of their own. Some maintained an orbit closer to the sun. We call these the inner planets and they are known as Mercury, Venus, Earth and Mars. The others—Jupiter, Saturn, Uranus and Neptune, were positioned farther from the life-giving heat of the sun. They are known as the outer planets. There were two planets, Earth and Mars, that were in a relatively good position to proliferate life because of their proximity to the sun. Some scientists believe that life in the form of microorganisms did exist on both planets but for some unknown reason died out on Mars. Therefore, maybe we can create an ecosystem on Mars that will function to support mankind.

We must understand the similarities and differences between Mars and the Earth and the changes that are deemed necessary to support life on the red planet. Presently it is uninhabitable because of certain physical environmental conditions. There is very little atmosphere and a food supply does not exist. The absence of water and water vapor is virtually non-existent for our needs. See below the composition of the atmosphere of Mars as compared to Earth's atmosphere.

	Earth	Mars
CO_2	03%	96.5%
Nitrogen	78.10%	1.8%
Oxygen	20.90%	.01%
Water	1.60%	.06%
Other.	09%1	.5%

The atmosphere on Mars is so thin that the heat from the sun just hits the planet and bounces right off back into space. The Earth's atmosphere holds on to most of its atmospheric gases. This causes a greenhouse effect to take place. Because of the small amount of oxygen and the great amount of carbon dioxide in Mars' atmosphere, man would not be able to breathe independently and heat would not be able to be held. This must be changed to one more similar to that of Earth's. The absence of an ozone layer, to protect living things from the ultraviolet rays of the sun, will develop if the atmosphere is changed.

There is no food supply on the red planet and a method must be devised to facilitate its production. Students already know, by fifth grade, that seeds and plants need sunlight for the process of photosynthesis to occur and that water and certain temperatures are necessary for growth to take place. They will need to reflect also on what they learned about short and long roots, multi-crop planting for greater food production, companion planting for pest control and a compost pile for fertilizer. The use of chemicals and their destructive potential should be reflected upon. Children also realize the necessities for life to develop and to sustain itself. Ask them, "How do we develop an ecosystem on Mars?" "How do we maintain a healthy ecosystem with communities that work together to maintain a healthy ecosystem?" The following is a series of steps that they will need to take and there should be some guidance in this direction. Discuss with them the changes that are necessary through thinking through questioning method. Let them, through their group, demonstrate how they would implement these changes.

Have children work in groups of four. Each person will be responsible for a particular task. They will have the following titles and job descriptions.

1. Chairperson - keeps group focused and helps to facilitate the team in working together efficiently.
2. Recorder - maintains all records and paperwork in a folder.
3. Organizer - takes charge of all materials that are needed for the project.
4. Media Specialist - retrieves material from the computer, the library and handles correspondence.

Problem Resolution

1. Give each group a styrofoam ball at least 6 inches in diameter. Cover each ball with homemade clay. The recipe is as follows:

Mix together 2 cups flour, 1 cup of iodized salt and 1 cup of water until thoroughly blended. Store in a Ziploc bag or airtight container.

Each group should research the terrain of Mars and take notes of the different landforms. These landforms should be formed into the clay using a variety of different materials. have a box filled with paper clips, small dowels, tin foil, sand paper, different textured materials, pencils, and other odds and ends that one could use to shape clay. Encourage children to be creative and contribute to the box. Cotton balls, pulled apart, can be used for the ice caps. Powdered detergent is also a good medium for the ice regions. Put the model of Mars aside to harden. It may be painted.

2. They will plan the building of a biosphere in the best place on their model. The group should decide on the science specialists that they want housed in the biosphere. They will decide on the data to be accumulated and how to lay out the biosphere for the appropriate ecosystem. They should reflect on the lessons on Biosphere 2.
3. A mode of transportation should be developed. Use Lego Systems, Capsela, Tinker Toys, Construx or nuts and bolts and other small devices.
4. The polar regions of Mars have ice and there are many natural basins and canals that exist on Mars. The group must develop a method of melting ice from the heat of the sun and channeling it into the canals and basins. Have available convex and concave lenses, pipe cleaners and small plastic tubing. Add to the box.
5. With the water from the ice collected and the basins and canals filled, trees and small plants could be planted around the water areas. They will begin to absorb the carbon dioxide and release oxygen into the atmosphere. Gradually more and more trees should be added. Fruit and flower bearing trees would be able to be used as food for birds and pollination respectively.
6. Facilitate the production of oxygen by building oxygen pumping stations. They would pump oxygen into the atmosphere. With the oxygen being pumped into the atmosphere, the air would begin to warm because it would be heavier and able to trap the rays of the sun. The ozone layer is now beginning to form.
7. Set up small biospheres on the planet to house a family unit.
8. Introduce small animals. They will go into the forest which should now be dense and also roam around the lakes and rivers. Aquatic life will be added along with birds, insects and bees. The people living on Mars would probably be vegetarians and the need for larger animals would not be necessary.

Conclusion

So here we are on Mars. We are living in a house on a new planet. The temperature is close to that of Earth's. There is an ozone layer and an atmosphere that houses clouds and holds heat. The sky is also blue. The rivers are filled with aquatic life and the rivers and other water bodies are surrounded by fauna that is edible and medicinal. There are trees for beauty and trees for shade and they also make up the forest which is the home for many animals.

How did we get here? Students learned how to create and maintain a balanced ecosystem. They also learned how to keep it safe. They know how to reduce, reuse and recycle trash. Pesticides are familiar to them and the dangers they impose. There will be alternatives to controlling pests that are not dangerous to man, animal or the environment.

The Solar System was part of the fourth grade science curriculum and children entered into this unit with a basic knowledge of why we could not live on Mars. So basically, they are taking knowledge from the past, newly learned knowledge and relating it to a problem that needs to be solved. It is not 100% scientifically correct, but the children learned to work in a cooperative group to solve a problem. I know that they will feel much academic success from such an attempt. Even though this generation of children will most likely not be settling Mars for years to come, they will have learned about their own planet and how to save it from vanishing as a viable habitat for mankind.

Students Resource

Ardley, Neal, *The Inner Planets* , Schoolhouse Press, Lexington, Mass. 1988.

Describes the inner planets, their characteristics and environment.

Baker, David, *Exploring Mars* , Rourke Enterprises, Inc., Vero Beach, Florida, 1994.

Discusses the exploration of *Mars* , focusing o the space flights made by unmanned probes, and examines possible developments and further exploration in the future.

Corrick, James, *Mars* , Venture, New York, 1991.

Describes the atmosphere and surface of Mars, including recent findings from NASA space probes, and surveys the history of our attempts to discover more about the planet.

Darling, David, *The Planets: The Next Frontier* , Dillon Press, Minn. MN, 1984.

Explains how each of the planets was most likely formed and presents information on what makes each planet so unique.

Rand McNally, *Children's Atlas of the Universe* , Chicago, Il., 1990.

Science Horizons , Sterling Edition, Silver Burdett Gins, Morristown, N.J., 1993.

Fourth grade science book for children.

Teacher Resource

Chandler, Pauline, *Ecology* , Teacher Created Materials Inc., Huntington Beach, Ca., 1994.

Schematic unit that is a hands-on, minds-on approach to learning. Each experiment states question, background, materials needed, procedures, extensions and closure. Included are activity sheets. Excellent unit.

Goldfarb, Theodore, *Taking Sides* , Duskin Publishing Group, Inc., Guilford, Conn., 1995.

Controversial views on controversial issues. Read some to students. Makes them think about different perspectives to a problem.

Grove, Sandra Ford, Dr. Hechtman, *Explore and Discover Reduce, Reuse and Recycle* , Creative Teaching Press, Inc., Cypress, Ca., 1996.

Simulated activities and hands-on explorations that help children to discover more ways to reduce, reuse and recycle our natural resources. Ten activities and easy to get materials. Complete lesson plans.

Jeavon, John, *How To Grow More Vegetables* , Ten Speed Press, Berkeley, Ca., 1991.

Demonstrates the latest findings for gardening methods. Great for kids to also use because of the illustrations.

Knight, Richard L. and Bates, Sarah, *A New Century for Natural Resource Management* , Island Press, Washington, D.C., Covelo, Ca., 1995.

New approaches concerning all aspects of the management of our natural resources.

Orteb, Edward and Richard Cadice, *Environment and Pollution* , Milliken Publishing Co., 1986.

A study of the factors that influence the relationship between living things and the environment. Special consideration is given to those human activities which adversely affect our environment. Includes ten color transparencies, activities and background. Excellent for classroom instruction and student activities.

Petulla, Joseph, *American Environmental History* , 2nd Ed., Merrill Publ. Co., Columbus, Ohio, 1995.

A study of the environmental history of the United States beginning with the colonial period and ending with the politics of pollution in the 1980’s.

Short, Kate, *Quick Poisons, Slow Poisons: Pesticide Risk in the Lucky Country* , Kate Short, St. Albans, NSW, 1994.

A series of actual case studies of pesticide poisonings. They include methods of absorption, effects of the poisoning and the outcome. Articles are short, easily comprehendable and makes for good read aloud material by the teacher to the students.

Smith, Zachary A., Environmental Policy Paradox, 2nd Ed., Prentice Hall, Englewood Cliffs, New Jersey, 1994.

An analysis of the contradictions between promise and performance in public policy for the environment.

Biosphere 2; e-mail, Veronica Gillen at vgillenbio2.edu.

Notes

1. Short, Kate, *Quick Poisons, Slow Poisons: Pesticide Risk in the Lucky Country* , Kate Short, St. Albans, NSW, 1994.
2. Carson, Rachel, *Silent Spring* , Houghton Mifflin Co., Boston, 1962.
3. Reprinted by permission from Dimension 2000, pg. 42, _1994 Berrent Publ., Inc. through the New Haven School System, New Haven, Conn.
4. Ibid.
5. Ibid.
6. Reprinted by permission from *Thinking Through Questioning* _1996 by Dr. Robert Paulker.
7. Jeavons, John, *How To Grow More Vegetables* , Ten Speed Press, Berkeley, Cal., 1991.

On Mars, we will therefore search for evidence of life in areas where liquid water was once stable, and below the surface where it still might exist today. Perhaps there might also be some current "hot spots" on Mars where hydrothermal pools (like those at Yellowstone) provide places for life.Â The current Martian climate is regulated by seasonal changes of the carbon dioxide ice caps, the movement of large amounts of dust by the atmosphere and the exchange of water vapor between the surface and the atmosphere.Â These questions will be addressed by studying Mars' geology. As part of the Mars Exploration Program, we want to understand how the relative roles of wind, water, volcanism, tectonics, cratering and other processes have acted to form and modify the Martian surface. Titled The Greening of Mars, the novel explores the formation and evolution of planets, the origin of life, and Earthâ€™s biosphere. The terraforming models presented in the book actually foreshadowed future debates regarding the goals of terraforming. Kim Stanley Robinsonâ€™s Red Mars Trilogy.Â And whereas this has been an unintended consequence of modernization and development here on Earth; on Mars, the burning of fossil fuels and the regular release of pollution into the air would have a positive effect. Infographic showing a cost-estimate and time frame for the terraforming of Mars. Credit: NASA/National Geographic Channel/Discovery Channel. Modern scientists have looked to Mars as a potential home for extraterrestrial life, a search that has reshaped how we explore and think about other planets.Â A new era of Mars exploration began, and this time the directive was simple: follow the water. An image of Mars taken from Viking lander, 1976. (Credit: NASA). Human Emissaries Arrive in the Form of Robotic Rovers. In 1976, robots served as our proxy, taking the first steps on Mars.Â The analogies between Earth and Mars have changed since the Victorian era, but the quest to learn from those parallels remains. Weâ€™re just looking back in time now. And now we want to know: If water existed on Mars when life arose on Earth, could life have existed on our neighbor?