DAILY LessonPlan

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Spacecraft Speed to Mars, High Hopes on Board
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Life on Mars: Science Fact or Science Fiction?

Investigating and Evaluating the Possibility of Life on Other Planets

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Grades: 6-12

Subjects: Current Events, Science, Technology
Interdisciplinary Connections

Overview of Lesson Plan: In this lesson, students investigate the basic requirements needed for human survival and contemplate the possibility of sustaining life on other planets, as is being researched by the recently-launched Mars Polar Lander and the Mars Climate Orbiter. As the main activity, students work in small groups to create a chart and a graph comparing statistics of the nine planets in the solar system and evaluating the elements that prevent life from flourishing on other planets.
Review the Academic Content Standards related to this lesson.

Suggested Time Allowance: 1 hour

Objectives:
Students will:
1. List and discuss the basic requirements for human survival (i.e., aspects of Earth?s atmosphere and on Earth itself).
2. Understand the relevance and meaning of several statistics offered on an Earth Fact Sheet; discuss how some of the statistics about the Earth provided by the fact sheet relate to the sustenance of human life and other life forms on Earth.

3. Work in small groups to create a chart and a graph comparing and evaluating the information provided on the fact sheet for an assigned planet to the statistics on the Earth fact sheet; present graphs to the class.
4. Read and discuss "Spacecraft Speed to Mars, High Hopes on Board."
5. Write a journal entry discussing the implications that a discovery of life on Mars at some point in time could have on scientific thought, beliefs and exploration in the future.

Resources / Materials:
-paper
-pens/pencils
-classroom blackboard
-copies of "Spacecraft Speed to Mars, High Hopes on Board" (one per student)
-copies of the Earth Fact Sheet, obtained on-line at the Planetary Sciences at the National Space Science Data Center Web site (http://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html) (one per student)
-copies of the fact sheets for the other eight planets in the solar system, found on-line at the Planetary Sciences at the National Space Science Data Center Web site (http://nssdc.gsfc.nasa.gov/planetary/planetfact.html) (one fact sheet for one planet per student, to be used in small groups of equal size)
-earth science textbooks or resources about the solar system and planets (to serve as references for the class activity)
-eight pieces of poster board
-eight large sheets of construction paper
-markers
-student journals

Activities / Procedures:
1. WARM-UP/DO NOW- In the first five minutes of class, students create lists on scrap pieces of paper of the basic requirements for human survival (i.e., aspects of Earth?s atmosphere and on Earth itself). Students then share their lists, and the teacher writes responses on the board. Why are humans unable to live on other planets? Why may plants and other living things be unable to live on other planets?

2. As a class, use the next five to ten minutes to look at and discuss the Earth Fact Sheet obtained from the Planetary Sciences at the National Space Science Data Center Web site (http://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html). Discuss the relevance of the following items on the fact sheet to understanding the sustenance of human life and other life forms on Earth: mass, volume, ellipticity, surface gravity, orbit periods (days), temperature, wind speeds, and major air composition. How are these aspects of our planet related to each other? (Advanced classes can discuss other facts presented on the fact sheet.)

3. Divide students into eight pairs or small groups, and assign each group one of the other eight planets in our solar system. Then, give each member of each group the appropriate fact sheet for the assigned planet also obtained from the Planetary

Sciences at the National Space Science Data Center Web site at (http://nssdc.gsfc.nasa.gov/planetary/planetfact.html), and give each group a piece of poster board and some markers. Each group then completes the following activities in the next 30 minutes of class (instructions should be written on the board):

a. On the poster board, create a chart comparing your planet?s statistics to Earth?s. Each chart should have six columns going across (you may want to use the "long" side of the sheet), labeled, from left to right, Measurement, Earth, Focus Planet (write the name at the top of the column), Livable/Unlivable, Reasons, and Modifications. Seven rows going down the left side of the paper (under the Measurement column) should be titled Mass, Volume, Ellipticity, Surface Gravity, Orbit Periods (Days), Temperature, and Wind Speeds.

--In the Earth column, write the statistics from the Earth Fact Sheet in the appropriate row.

--In the focus planet column, write the statistics from their planet?s fact sheet in the appropriate row.

--Compare the statistics and evaluate whether or not you feel that humans could live or not live with each of the conditions. Write "livable" or "unlivable" under the appropriate column and in the corresponding rows.

--In the Reasons column, offer the justification to each of your responses in the "Livable/Unlivable" column.

--In the Modifications column, write what you feel humans would need to do (such as inventing a specific new type of technology) in order to survive under each condition.

b. On a sheet of construction paper, create a graph illustrating the differences in major air composition between Earth and the assigned planet.

Groups should then briefly present their graphs to the class. Graphs should be posted in the classroom for future reference.

4. Read and discuss "Spacecraft Speed to Mars, High Hopes on Board," focusing on the following questions:

a. Why do some scientists believe that life once existed on the planet Mars? What proof do they believe that they have?

b. What purposes will the Mars Climate Orbiter and the Mars Polar Lander serve in the quest for evaluating whether or not life, at one time, existed on Mars?

c. What other planetary body has been explored as intently as Mars has been, and why?

d. Why were missions to other planets "piecemeal" and "often inadvertently left. . .vulnerable to political whims and uncertainties"?

e. Why, according to scientists, is it "very plausible" for there to be evidence of past life on Mars?

f. What will the Mars Polar Lander do upon landing on Mars?

g. How does money affect space missions?

h. What did the Pathfinder mission in July 1997 accomplish? How did that mission differ from the missions of the Mars Climate Orbiter and the Mars Polar Lander?

i. How will the microprobes work, and what will they obtain? What do scientists hope to learn?
j. What is the Mars Global Surveyor, and what information about Mars has it provided?

5. WRAP-UP/HOMEWORK: Students respond to the following question in a one-page long journal entry: If the Mars Polar Lander finds that there has been life on Mars at some point in time, what implications might this discovery have on scientific thought, beliefs and exploration in the future? Students should share their ideas in the beginning of the next class.

Further Questions for Discussion:
--What are the basic requirements for human survival (i.e., aspects of Earth?s atmosphere and on Earth itself)?
--Why are humans unable to live on other planets? Why may plants and other living things be unable to live on other planets?
--In what ways does our society demonstrate a great interest in the pursuit to find out about life on other planets?
--What elements do scientists look at to determine whether or not a star or planet can support life?
--Why do some scientists believe that life once existed on the planet Mars? What proof do they believe that they have?
--What purposes will the Mars Climate Orbiter and the Mars Polar Lander serve in the quest for evaluating whether or not life, at one time, existed on Mars?
--Why, according to scientists, is it "very plausible" for there to be evidence of past life on Mars?
--How does money affect space missions?
--How will the microprobes from the Mars Polar Lander work, and what will they obtain? What do scientists hope to learn?
--If it is found that there has been, at some point, life on Mars, what implications might this discovery have on scientific thought, beliefs and exploration in the future?
--What are some of the existing theories about whether or not there is life on other planets?
--How is the search for life on other planets infused into various aspects of our culture?

Evaluation / Assessment:
Students will be evaluated based on participation in class discussions, thoughtful and focused participation in small group research and discussion activity, and written journal response.

Vocabulary:
probes, inquiry, propulsion, rover, riveted, exploratory, planetary, ambitious, culminated, haphazardly, piecemeal, vulnerable, microscopic, extant, plausible, microbial, aquifers, inadvertently, contaminating, forerunner, relentless, projectile, laden, originate

Extension Activities:
1. Diagram or create a flow chart demonstrating how the microprobes used by the Mars Polar Lander will work.

2. Create an illustrated space exploration timeline.

3. Research different space probe missions and the information obtained.

4. Obtain core samples from the earth at your school or at home (be sure to obtain your administrators? or parents? permission first!) by digging to a specific depth. Map or illustrate the layers that you see and research what may comprise those layers.

5. Collect and analyze rocks that you find at school or at home. What do these rocks tell you about your geographic area?

6. Explore NASA?s developments and discoveries in the past four decades. What have we learned about Earth, our solar system, the universe, physics, and space exploration?

7. Investigate NASA?s contributions to the areas of health, technology and inventions.

8. Create an accurately-scaled model of the solar system based on the statistics offered in class.

9. Research the development and uses of different space technologies (e.g, space probes, orbiters, rockets, radar, heat sensors, satellites, space stations).

Interdisciplinary Connections:
American History- Study the evolution of the United States space program, focusing on successes, obstacles, tragedies, competition with other nations, and future projects.

Fine Arts- Search on-line to locate song lyrics written about the excitement and perils of space travel.

Geography- Learn about how geography affects the weather and earth?s climate (such as the creation of seasons). What is geography?s role in the survival of species on Earth?

Global History- Study other countries' space programs and their contributions to our knowledge about the universe.

Language Arts
-Imagine that you are involved in the sending of messages into outer space in the

expectation that they will be received by extraterrestrials. Develop a plan for what messages you would send, as well as how you would respond if you received a response back.
-Read a science fiction short story or novel about human interactions with extraterrestrial beings (such as Ray Bradbury?s The Martian Chronicles).
-Find poetry written about space travel or the cosmos and read the works for the class.
-Write a short story or several journal entries from the perspective of a space alien who lands on Earth in the year 1999.

Mathematics- Create a graph or series of graphs comparing the quantifiable statistics about the nine planets in our solar system as learned about in the class activity.

Media Studies- Watch movies and television shows with plots about beings from other planets. How are aliens characterized? What do these characterizations say about our hopes, fears, and expectations about life forms from other planets?

Additional Related Articles:
NASA at 40 (http://www.nytimes.com/nasa) is The New York Times on the Web's look at NASA's accomplishments over the past four decades.
"Craft Joins Mars Quest For Water" (1/4/99)
"Spacecraft Is Launched to Look for Water on Mars" (12/12/98)
"Pathfinder Probe Transforms Red Planet Into the Whistling Planet" (11/10/98)
"U.S. Launches A Spacecraft That Thinks For Itself" (10/25/98)
"Around the Mars Pathfinder in 83 Days" (7/21/98)

Other Information on the Web
Students can find a wealth of information about historic and current space programs by accessing NASA?s homepage at (http://www.nasa.gov).

NASA?s Quest Project on the Web (http://quest.arc.nasa.gov) introduces kids to NASA experts, let them follow the aerodynamic testing of a Wright Brothers plane, and tour the International Space Station.

The Mars Surveyor ?98 Home Page (http://mars.jpl.nasa.gov/msp98/index.html) contains mission overviews of the Mars Climate Orbiter and the Mars Polar Lander, images and photos, technology, and related links.

The NASA Jet Propulsion Laboratory at California Institute of Technology (http://www.jpl.nasa.gov) offers news and pictures regarding the solar system, Earth, the universe, technology, and past and present NASA missions.

The Mars Polar Lander Web site (http://www.marspolarlander.com) offers a

mission overview, science goals, instruments, landing site, press releases, a fact sheet, and frequently asked questions about the Mars Polar Lander.

Mars Exploration Education Program (http://marsnt3.jpl.nasa.gov/education/index-education.html) provides curriculum guides, Mars missions fact sheets, slides and images, and copies of newsletters for Mars Exploration at the Jet Propulsion Laboratory.

The Space Place Launch Pad (http://spaceplace.jpl.nasa.gov) is a terrific Web site for science projects in school or at home. The site includes sections titled Make Spacey Things, Do Spacey Things (games and puzzles), Space Science in Action, Amazing Facts from Dr. Marc, and Our Friends Share (art submitted by Web site visitors and fans).

Academic Content Standards:

This lesson plan may be used to address the academic standards listed below. These standards are drawn from Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education: 2nd Edition and have been provided courtesy of the Mid-continent Research for Education and Learning in Aurora, Colorado.

In addition, this lesson plan may be used to address the academic standards of a specific state. Links are provided where available from each McREL standard to the Achieve website containing state standards for over 40 states. The state standards are from Achieve's National Standards Clearinghouse and have been provided courtesy of Achieve, Inc. in Cambridge Massachusetts and Washington, DC.

Grades 6-8
Science Standard 1- Understands basic features of the Earth. Benchmarks: Knows that the Earth is the only body in our solar system that appears able to support life; Knows the composition and structure of the Earth's atmosphere (e.g., temperature and pressure in different layers of the atmosphere, circulation of air masses); Knows how the tilt of the Earth's axis and the Earth's revolution around the Sun affect seasons and weather patterns; Knows factors that can impact the Earth's climate; Knows the properties that make water an essential component of the Earth system; Knows that the Sun is the principle energy source for phenomena on the Earth's surface
Science Standard 3- Understands essential ideas about the composition and structure of the universe and the Earth's place in it. Benchmarks:
Knows characteristics of our Sun and its position in the universe; Knows characteristics and movement patterns of the nine planets in our Solar System; Knows that the planet Earth and our Solar System appear to be somewhat unique, although similar systems might yet be discovered in the universe; Knows that gravitational force keeps planets in orbit around the Sun and moons in orbit around the planets
Science Standard 14- Understands the nature of scientific knowledge. Benchmarks: Knows that all scientific ideas are tentative and subject to change and improvement

in principle, but for most core ideas in science, there is much experimental and observational confirmation; Understands that questioning, response to criticism, and open communication are integral to the process of science
Science Standard 15- Understands the nature of scientific inquiry. Benchmarks: Knows that there is no fixed procedure called "the scientific method," but that investigations involve systematic observations, carefully collected, relevant evidence, logical reasoning, and some imagination in developing hypotheses and explanations; Understands the nature of scientific explanations; Knows possible outcomes of scientific investigations
Science Standard 16- Understands the scientific enterprise. Benchmarks: Knows that throughout history, many scientific innovators have had difficulty breaking through accepted ideas of their time to reach conclusions that are now considered to be common knowledge; Knows ways in which science and society influence one another
Technology Standard 3- Understands the relationships among science, technology, society, and the individual. Benchmarks: Knows that scientific inquiry and technological design have similarities and differences; Knows that science cannot answer all questions and technology cannot solve all human problems or meet all human needs; Knows ways in which technology has influenced the course of history; Knows that technology and science are reciprocal; Knows ways in which technology and society influence one another

Grades 9-12
Science Standard 1- Understands basic features of the Earth. Benchmarks: Knows the major external and internal sources of energy on Earth; Knows that weather and climate involve the transfer of energy in and out of the atmosphere; Knows how winds and ocean currents are produced on the Earth's surface; Knows how life is adapted to conditions on the Earth
Science Standard 3- Understands essential ideas about the composition and structure of the universe and the Earth's place in it. Benchmarks: Knows ways in which technology has increased our understanding of the universe; Knows that evidence suggests that our universe is expanding
Science Standard 14- Understands the nature of scientific knowledge. Benchmarks: Knows ways in which science distinguishes itself from other ways of knowing and from other bodies of knowledge; Knows that scientific explanations must meet certain criteria to be considered valid; Understands how scientific knowledge changes and accumulates over time; Knows that from time to time, major shifts occur in the scientific view of how the world works, but usually the changes that take place in the body of scientific knowledge are small modifications of prior knowledge
Science Standard 15- Understands the nature of scientific inquiry. Benchmarks: Understands the use of hypotheses in science; Knows that conceptual principles and knowledge guide scientific inquiries, and that historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists
Science Standard 16- Understands the scientific enterprise. Benchmarks:

Knows that science and technology are essential social enterprises, but alone they can only indicate what can happen, not what should happen; Knows that creativity, imagination, and a good knowledge base are all required in the work of science and engineering
Technology Standard 3- Understands the relationships among science, technology, society, and the individual. Benchmarks: Knows that science and technology are pursued for different purposes; Knows ways in which social and economic forces influence which technologies will be developed and used; Knows examples of advanced and emerging technologies; Knows that mathematics, creativity, logic, and originality are all needed to improve technology

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