Living on Mars: Growing Plants in a Greenhouse

Student Level:
Middle School (6-8)

Objectives:

- Students will think critically about how to establish and maintain a suitable environment for life.

Resources:

- 1- or 2-liter soda bottles (empty & clean)
- thermometers
- clay, sand, potting soil, etc.
- starter plants or quick-germinating seeds (perhaps of several species)
- chopsticks (or other long, thin rods)
- aluminum foil

Outcomes:

- Students will create and run experiments to discover the optimal conditions for growing plants in a contained environment.

Assessment:

- Were the students able to design and execute experiments that demonstrated how different environmental conditions affect plant growth?

Time:

About 45 minutes for the first part of the lesson; about five minutes, several times a week, for the duration of the experiments; about 45 minutes for the final part of the lesson.

Procedure:

~5 minutes:

Introduce the lesson by explaining that explorers on Mars will need to have greenhouses for growing food, and also for recycling air and water. Plants will need to be grown indoors, because the Martian atmosphere is only 1% as thick as Earth's and very cold, and the Martian soil is inorganic and dry at the surface (this should be written down for the students). The students' task in this exercise is to identify some of the variables in setting up and managing a greenhouse.

~10 minutes:

Lead the students, through the use of open-ended questions, in a discussion about the variables that might affect the growth of plants; some important ones that should be covered are availability of water, type of soil, temperature of air, amount of sunlight, and species of plant.

~30 minutes:

Have the students, in groups, select a variable that they will investigate (the selection could be by choice or by chance, at teacher's discretion). They will design an experiment with two, three, or more variations of the variable, while seeking to keep other variables constant (i.e., a group investigating the effect of different soil types might have three bottles, one containing clay, on sand, and one potting soil, into which they put the same types of plants, which receive the same amount of water and sunlight through the course of the experiment). After writing a description of their experiment and writing their hypothesis (how will changes in the variable affect the plants?), the students set up their bottle greenhouses (the chopsticks are to help dig and plant within the bottles; the aluminum foil can be used as a reflective backing or frontal shading to either increase or decrease sunlight and temperature). The experiments could be set in a sunny spot in the classroom or in a safe location outside, where they can remain undisturbed for the duration of the experiment (perhaps one to three weeks). At regular intervals, students should water and examine the experiments and record their observations (i.e., temperature of greenhouse, height of plant, etc.).

~20 minutes:
At the end of the experiment, each group should retrieve its greenhouses, review its hypothesis, and analyze its data. In order to clarify and demonstrate their understanding, have the students answer (in writing) some questions, such as:

- Did changes in the variable affect the growth of the plants? How?
- Was the hypothesis correct?
- How might the experiment be improved?

~25 minutes
Then have the groups present, in turn, their findings to the rest of the class. Then lead the class in synthesizing the results, in order to describe the ideal design of a greenhouse to support Martian explorers.

Standards Addressed:

California:
Science, Grade 6
5.e. Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

Florida:
Science, Grades 6-8, How Living Things Interact with Their Environment
1.4 The student knows that the interactions of organisms with each other and with the nonliving parts of their environments result in the flow of energy and the cycling of matter throughout the system.
1.5 The student knows that life is maintained by a continuous input of energy from the sun and by the recycling of the atoms that make up the molecules of living organisms.
2.2 The student knows that all biotic and abiotic factors are interrelated and that if one factor is changed or removed, it impacts the availability of other resources within the system.
2.4 The student knows that humans are a part of the ecosystem and their activities may deliberately or inadvertently alter the equilibrium in ecosystems.

New York:
Science, The Living Environment
5. Organisms maintain a dynamic equilibrium that sustains life.
6. Plants and animals depend on each other and their physical environment.
7. Human decisions and activities have a profound impact on the physical and living environment.

Texas:
Science, Grade 6
13. The student knows components of our solar system; the student is expected to: A) identify characteristics of objects in our solar system and B) describe type of equipment and transportation needed for space travel.
Science, Grade 7
12. The student knows that there is a relationship between organisms and the environment; the student is expected to: A) identify components of an ecosystem and B) observe and describe how organisms live together in an environment and use existing resources.
Science, Grade 8
6. The student knows that interdependence occurs among living systems; the student is expected to: C) describe interactions within ecosystems.