Mars Habitat Design

Objectives

Students Will:

- Learn about Mars habitat designs
- Discuss various human needs during long-term space travel/dwelling
- Design and construct a habitat suitable for living on Mars

Suggested Grade Level

3rd – 12th

Subject Areas

Space Science, Technology, Engineering Design, Life Science

Timeline

One 45-minute session – Multiple sessions/semester-long

Standards (NGSS)

- **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost
- **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem
- **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions
- **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem
- **HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering
- **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts

21st Century Essential Skills

Critical thinking, problem solving, creativity/imagination, collaboration, teamwork, communication, flexibility, leadership, initiative, organizing concepts, construct explanations, design solutions

Background

The fourth planet from the Sun, Mars is a dusty, cold, desert world with a very thin atmosphere. This dynamic planet has seasons, polar ice caps and weather and canyons and extinct volcanoes, evidence of an even more active past.

Mars is one of the most explored bodies in our solar system, and it's the only planet where we've sent rovers to roam the alien landscape. NASA currently has three spacecraft in orbit, one rover and one lander on the surface and another rover under construction here on Earth. India and ESA also have spacecraft in orbit above Mars. These robotic explorers have found lots of evidence that Mars was much wetter and warmer, with a thicker atmosphere, billions of years ago.

The Red Planet is actually many colors. At the surface we see colors such as brown, gold and tan. The reason Mars looks reddish is due to oxidization—or rusting—of iron in the rocks, regolith (Martian “soil”), and dust of Mars. This dust gets kicked up into the atmosphere and from a distance makes the planet appear mostly red.

Mars appears to have had a watery past, with ancient river valley networks, deltas and lakebeds, as well as rocks and minerals on the surface that could only have formed in liquid water. Some features suggest that Mars experienced huge floods about 3.5 billion years ago.

There is water on Mars today, but the Martian atmosphere is too thin for liquid water to exist for long on the surface. Today, water on Mars is found in the form of water-ice just under the surface in the polar regions as well as in briny (salty) water, which seasonally flows down some hillsides and crater walls.

Mars has a thin atmosphere made up mostly of carbon dioxide, nitrogen and argon gases. To our eyes, the sky would be hazy and red because of suspended dust instead of the familiar blue tint we see on Earth. Mars' sparse atmosphere doesn't offer much protection from impacts by such objects as meteorites, asteroids and comets.

The temperature on Mars can be as high as 70 degrees Fahrenheit (20 degrees Celsius) or as low as about -225 degrees Fahrenheit (-153 degrees Celsius). And because the atmosphere is so thin, heat from the Sun easily escapes this planet. If you were to stand on the surface of

Mars on the equator at noon, it would feel like spring at your feet (75 degrees Fahrenheit or 24 degrees Celsius) and winter at your head (32 degrees Fahrenheit or 0 degrees Celsius).

Scientists don't expect to find living things currently thriving on Mars. Instead, they're looking for signs of life that existed long ago, when Mars was warmer and covered with water.

Astronauts on Red Planet missions will have to contend with deep-space radiation, the effects of microgravity and the stress of confinement and isolation, all at the same time and for a long, continuous stretch. It currently takes a minimum of six months to get to Mars, after all, and just as long to get back.

Some of the stressors are more concerning than others. For example, researchers and NASA officials have repeatedly cited radiation as one of the biggest Mars-mission hazards.

Vocabulary

Habitat, design, long-term space travel, engineering

Materials

Design material examples:

- Project notebooks
- Pencils
- Scratch paper
- White boards and markers

Basic material examples:

- Construction paper
- Craft sticks
- Pipe cleaners
- Toothpicks
- Index cards
- K'nex
- Legos

Junk material examples:

- Plastic bottles
- Containers of various sizes
- Cardboard (large and small pieces)
- Cups of various sizes
- Lids

- Fabric scraps
- Egg cartons
- TP rolls
- Red sand/rocks

Advanced material examples:

- 3D printers and software
- Architecture/design software
- Plaster of Paris

Lesson

1. Discuss background information based on how in-depth the lesson will become. Basic knowledge about mars and the history of long-term space travel will be useful for all students. If taking the lesson more in depth through 3D design or project management, discuss background on those topics as well.
2. Assign students to small groups (activity also works individually).
3. Groups will discuss and record ideas for their habitat. Things may include what kinds of rooms they should have, what the most important features would be for their astronauts, etc.
4. Groups must first design their Mars habitat using materials like a project notebook, white boards, or 3D design software.
5. After designing, students can begin constructing their habitat. Explain each of the materials available and give directions on the use of the materials if needed.
6. Set a time limit for habitat construction. If breaking the activity into multiple sessions, discuss with students the time constraints for each session and what they should have accomplished by the end of each. If beginning with project management, dedicate the first session to project management skills, group discussions, and assigning roles.
7. After habitat construction is complete, groups must present their habitat and explain the features they chose to build and why they felt those were the most important features.

Extensions

1. Connect a writing activity by having students write a journal as if they were an astronaut living in the habitat they just constructed.
2. Allow students to research further into the world of Mars habitat design and explore the prototypes which have been developed thus far.
3. Teach about hydroponics and have students build a mini hydroponic garden for their habitat.

Resources

Five Structures for Helping Students Learn Project Management. (2019, March 06). Retrieved from http://www.spencerauthor.com/project-management/

Harbaugh, J. (2018, July 23). Five Teams Win a Share of $100,000 in 3D-Printed Habitat Competition. Retrieved from https://www.nasa.gov/directorates/spacetech/centennial_challenges/3DPHab/five-teams-win-a-share-of-100000-in-virtual-modeling-stage

In Depth. (n.d.). Retrieved from https://solarsystem.nasa.gov/planets/mars/in-depth/

Kshama. (2018, July 04). The Basic Principles of Project Management. Retrieved from https://www.simplilearn.com/project-management-basic-principles-article

Mohon, L. (2015, May 15). NASA's Centennial Challenges: 3-D Printed Habitat Challenge. Retrieved from https://www.nasa.gov/directorates/spacetech/centennial_challenges/3DPHab/index. html
Project Management Basics. (2013, December 16). Retrieved from https://www.usability.gov/what-and-why/project-management.html

Wall, M. (2019, August 27). Astronauts Will Face Many Hazards on a Journey to Mars. Retrieved from https://www.space.com/crewed-mars-mission-astronaut-dangers.html