Middle School Lesson Plan

Mission Ready: Building Your Mars Crew

AEROSPACE | STEM

Lesson Overview	Career Highlight
Students will be introduced to several scientific missions that serve as analogs to Martian habitats, focusing on the Flashline Mars Arctic Research Station (FMARS) and Mars Desert Research Station (MDRS) in Utah. Students will learn about the copious real-world preparation required to facilitate Mars exploration, and will identify challenges of living and working in such extreme environments. Students will then engage in their own Mars simulation by taking on different roles in a mission to survive on "Mars" for 30 days.	**Commander:** Mission leader, makes final decisions, coordinates with Earth **Executive Officer:** Second-in-command, assists commander, leads in emergencies **Engineer:** Maintains equipment, fixes problems, manages power and life support **Scientist (Geologist):** Studies rocks, soil samples, maps terrain features **Scientist (Biologist):** Searches for signs of life, manages greenhouse, studies extremophiles **Health & Safety Officer:** Monitors crew health, manages medical emergencies, ensures safety protocols **Journalist:** Documents mission, communicates with public, maintains crew morale

STEM Course Connections	21st Century Skills	CTE Alignment
Middle School Biology Middle School Earth Science	Collaboration Problem Solving Critical Thinking	Engineering and Design Industry Sector (ED)

Materials
● Mars Habitat Reading ● Mars Simulation Examples ● Mars Simulation Roles

- Mission Patch Brief
- Student Handout
- Survival Scenario

Essential Questions

1. What are analog missions, and why are they vital for preparing astronauts for space exploration?
2. How do desert and arctic environments on Earth simulate conditions relevant to space exploration, and what are the unique challenges each environment presents?
3. What are the primary challenges humans would face on Mars, including isolation, extreme cold, and limited resources, and how might these challenges be overcome?
4. Why is international collaboration crucial in advancing space research and exploration, and what benefits does it offer to participating countries?
5. How can students effectively prepare for a conversation with a space industry professional, and what meaningful questions should they ask to gain insights into current trends and future opportunities in space exploration?

Prerequisite Knowledge

This lesson is intended to be taught after From Ice to Dust: Exploring Mars Through Earth Analogs where students will learn about analog missions, differences between the habitats of Arctic and desert ecosystems, and how they are similar and different from Mars. Students should know the following terms in order to be successful in this lesson: Analog mission, astrobiology, EVA (extravehicular activity), habitat, life support, permafrost, extremophile, isolation protocol.

Introduction (15 minutes)

Remind students of the analog missions described in the lesson, From Ice to Dust: Exploring Mars Through Earth Analogs.

- Analog missions are Earth-based simulations where scientists and researchers practice Mars exploration in environments that share key characteristics with Mars.

Ask students: Why simulate Mars on Earth?

- **Test equipment:** Spacesuits, rovers, communication systems, life support
- **Practice procedures:** Daily routines, emergency protocols, scientific research methods
- **Study human factors:** Isolation effects, team dynamics, psychological challenges
- **Cost-effective:** Much cheaper than sending equipment to Mars first
- **Safety:** Learn from mistakes on Earth rather than on Mars

In groups of 3, students will each receive one of three Mars Simulation Examples that they will read about and summarize in their Student Handout. When they are finished, students will share their Mars simulation example with the rest of the students.

Mars Research Station Utah (20 minutes)

World Cafe Directions

- In 4 small groups, students will participate in a World Cafe where each group receives a different page of the Mars Habitat Reading.
- After 5 minutes reading and writing down their notes on a shared poster paper, one of the group members stays behind while the rest of the group rotates to the next table to read the next page of the Mars Habitat Reading.
- The "host," who stayed behind, fills the group in about the notes that were shared and then the new team spends the next 5 minutes reading and adding to the notes. This repeats until the group has rotated back to the original table and the "host" shares what was added since the first rotation.

After the groups return, the "hosts" can share the highlights from each group to the rest of the class.

Mars Mission Team Selection (20 minutes)

Instructions:
Working in groups of 6, students will create their Mars mission crew by assigning roles and explaining their choices. Teacher will first share the slips of paper on the first 2 pages of Mars Simulation Roles.

Available Roles:
- **Commander:** Mission leader, makes final decisions, coordinates with Earth
- **Executive Officer:** Second in command, assists commander, leads in emergencies
- **Engineer:** Maintains equipment, fixes problems, manages power and life support
- **Scientist (Geologist):** Studies rocks, soil samples, maps terrain features
- **Scientist (Biologist):** Searches for signs of life, manages greenhouse, studies extremophiles
- **Health & Safety Officer:** Monitors crew health, manages medical emergencies, ensures safety protocols
- **Journalist:** Documents mission, communicates with public, maintains crew morale

Students will record their responses to the team planning questions in their Student Handout.

Team Planning Questions:
1. Why did you choose each person for their role?
2. What backup skills should each person have?
3. How will you handle conflicts or disagreements?
4. What happens if someone gets sick or injured?

Design a team mission patch. Show each group the Mission Patch Brief that includes an image of a real Mars simulation mission patch and a description of components to include in their own patch.

Flashline Mars Arctic Research Station (15 minutes)

Each student will receive specific information depending on their role. Once they have established their role, they will receive a role card and on the reverse will be some useful information about Flashline Mars Arctic Research Station. Students will share their role card information with each other and write down important information in the Student Handout.
- Discuss team agreements and commitments after each student has had an opportunity to understand their individual roles.

Survival Planning & "Land on Mars" Scenario (30 minutes)

Scenario Setup:

"Your crew has just landed on Mars near the polar ice cap. Your main habitat module has been damaged during landing. You have limited supplies and must survive for 30 days until the next supply mission arrives."

Pass out the Survival Scenario with the survival challenges and available supplies listed.

Survival Challenges:

- Temperature: -60°C during the day, -120°C at night
- Atmosphere: Unbreathable, requires constant life support
- Water: Must be extracted from ice or recycled from waste
- Food: Limited supplies, growing food takes months
- Power: Solar panels work but dust storms can last weeks
- Communication: 20-minute delay with Earth

Available Supplies:

- Emergency shelter (good for 10 days)
- 45 days of food rations
- Water recycling system (90% efficiency)
- Solar panels + backup battery (3 days power)
- First aid kit
- Basic tools and repair materials
- Communication equipment
- 2 EVA suits (for going outside)

Group Planning Activity:
Each team receives a Survival Scenario with a "supplies inventory" and must create a 30-day survival plan in their Student Handout.

Students will answer the planning questions in the Student Handout.

Planning Questions:

1. **Shelter:** How will you repair/extend your living space?
2. **Water:** How will you ensure clean water for 30 days?
3. **Food:** How will you ration food and what if supply is delayed?
4. **Power:** How will you conserve energy and handle dust storms?
5. **Health:** What medical emergencies worry you most?
6. **Roles:** How will you divide daily responsibilities?
7. **Morale:** How will you handle stress and conflict?

At the end of the planning process, each group will share their top 3 survival strategies with the class.

Mission Journal & Wrap-up (10 minutes)

In the Student Handout, students will write a 1-page journal entry as if they are preparing for their first analog mission.

At the end of the class, students can record their responses to the reflection questions in their Student Handout.

Reflection Questions:

1. What surprised you most about analog missions?

2. Which environment (Arctic or desert) would be harder for you personally? Why?
3. What questions do you want to ask our guest speakers?
4. How do you think your Mars mission team would handle real isolation and stress?

Extension

Extension Activities:

- Research current Mars missions (Perseverance, Ingenuity helicopter)
- Design improvements for analog research stations
- Create a timeline of Mars exploration history
- Investigate careers in space exploration and astrobiology

Optional: Contact the Aerospace Corporation to schedule a virtual visit with an aerospace professional (stem@aero.org).

CA NGSS Standards

MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

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.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

CTE Alignment

C1.0 - Understand historical and current events related to engineering design
C3.0 - Understand the sketching process used in concept development
B6.0 - Employ the design process to solve analysis and design problems
B6.1: Understand the steps in the design process
B6.2: Determine relevant information and principles for problem analysis
B6.3: Choose between alternate solutions and justify choices
B7.0 - Understand industrial engineering processes
B7.1: Know the structure and processes of a quality assurance cycle
B7.3: Use tools and joining systems in engineering processes
B8.0 - Understand fundamental control system design
B8.1: Identify elements necessary to develop controlled systems
B8.2: Demonstrate use of sensors for data collection
B10.0 - Design and construct a culminating project effectively
D2.0 - Understand the design process for analysis and design problems
D3.0 - Understand fundamentals of earth science as they relate to environmental engineering
D3.2: Understand effects of pollution on hydrological features
D3.4: Analyze importance and use of soil

Resources

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