Middle School Lesson Plan

From Ice to Dust: Exploring Mars Through Earth Analogs

AEROSPACE | STEM

Lesson Overview	Career Highlight
This engaging Mars exploration lesson challenges middle school students to become "Mars Mission Scientists" by investigating Earth's most extreme environments as training grounds for future Mars exploration. Students rotate through hands-on stations comparing Arctic and desert ecosystems, examining climate adaptations, analyzing geological samples, building ecosystem models, and making critical survival decisions. Through tactile experiences with temperature simulation boxes, soil samples, and matching activities, students discover how scientists use Earth analogs such as Devon Island, Canada and Utah's red rock desert to prepare for Mars missions. The lesson culminates with students creating three-way Venn diagrams comparing Arctic, desert, and Martian conditions, while connecting their learning to real aerospace careers. By investigating how organisms survive in Earth's harshest environments, students develop critical thinking skills essential for space exploration while exploring STEM career pathways in aerospace engineering, astrobiology, and planetary science.	**Astrobiologist:** Studies potential for life in extreme environments like Mars **Environmental Systems Engineer:** Designs life support systems for human space exploration **Mission Operations Specialist:** Plans and executes space missions using analog training, which is a simulated mission that prepares astronauts for future space exploration **Planetary Geologist:** Analyzes surface conditions and geological features of other planets **Systems Test Engineer:** Tests equipment in Mars-like conditions on Earth

STEM Course Connections	21st Century Skills	CTE Alignment
Middle School Biology Middle School Earth Science	Critical Thinking & Problem Solving Communication & Collaboration Creativity & Innovation Information & Technology Literacy	Engineering & Architecture

Materials

- Cornstarch and water
- Frozen soil or clay
- Heat pads or warmed rice bags
- Ice packs, packing peanuts, cotton balls, or fake snow (or crumbled Styrofoam)

- Kinetic sand or dry play sand in trays
- Magnifying glasses, brushes, gloves
- Modeling clay or a plastic container filled with frozen wet soil
- Mystery images
- Porous pumice stone or red-painted gravel
- Sand, sandstone, or cracked dry soil
- Small poster boards labeled “Arctic” and “Desert” (2)
- Smooth or eroded rock
- Station Instructions
- Station 1 Animal Examples
- Station 4 Scenarios and Survival Items
- Station 3 Cutout Cards
- Student Handout
- Thermometers
- Optional**:** Faux fur swatches for Arctic animals
- Optional: A plastic water bottle wrapped in fabric to simulate blubber
- Optional: Plastic ears of different sizes (e.g., paper fan for fennec fox ears) to "feel" heat loss with a fan
- Optional**:** Toy models of plants, animals, and other physical features (e.g., cactus, polar bear, igloo, sand dune)

Essential Questions

1. How do organisms survive in Earth's most extreme environments, and what can this teach us about the possibility of life on Mars?
2. Why do scientists use Earth's Arctic and desert regions as "training grounds" for Mars exploration, and what similarities make these locations effective analogs or simulated missions that prepare astronauts for future space exploration?
3. How do environmental factors like temperature, water availability, and atmospheric conditions shape the types of life that can exist in an ecosystem?
4. What adaptations and technologies would humans need to survive on Mars, and how can we test these solutions using Earth's extreme environments?
5. What role does engineering design play in preparing humans for space exploration, and how do Earth-based simulations help solve Mars mission challenges?

Prerequisite Knowledge

Students should know what an ecosystem is and observable characteristics that could help determine which organisms will thrive in an ecosystem. A background in basic ecology and habitats as well as animal adaptations is important.

Introduction (15-20 minutes)

Display three mystery images side by side without labels:

1. Devon Island, Arctic Canada (rocky, barren landscape)
2. Utah desert (red rocks, sparse vegetation)

3. Mars surface (from rover images)

See, Think, Wonder: Guided discussion

- Tell students to first look at these three images and ask them what they "see" in the picture. Ask them to record their response on the Student Handout.
- Next, tell students to first look at these three images and ask them what they "think" in the picture. Ask them to record their response on the Student Handout.
- Finally, tell students to first look at these three images and ask them what they "wonder" in the picture. Ask them to record their response on the Student Handout.

Guiding Question: "Which of these is NOT from Earth?"

Allow students to discuss and vote. Reveal that two are from Earth and explain that scientists use these Earth locations to practice for Mars missions.

Guiding Question: "What do we already know about Mars?"

Allow students an opportunity to brainstorm everything they know about Mars and add to a list on the board as a class.

Arctic vs. Desert Stations (40-60 minutes)

Teacher Set Up

- The teacher will set up four stations around the classroom that can accommodate a small group of students.
- Each station will include instructions (Student Tasks) for the students to walk through the station on their own and record responses in their Student Handout.
- *Some of the stations involve preparation ahead of time*.

Station 1: "Feel the Climate" – Temperature & Adaptation

- **Materials:**
  - Two small boxes with materials inside to simulate climate conditions:
    - Box A: Arctic simulation - use ice packs wrapped in foil/cloth, cotton to simulate snow, sealed to be touched safely
    - Box B: Desert simulation - use heat pads or warmed rice bags, dry sand or pebbles, simulate dryness
  - Thermometers (or simulated temps)
  - Station 1 instructions
  - Photos of Arctic vs. desert animals (printed and cut out)
- **Student Task:**
  - Feel each "climate box" and guess the conditions
  - If using a thermometer, record the temperature in the Student Handout
  - Discuss: What would YOU wear to survive in each?
  - Matching Game**:** Laminate animal cards and adaptation fact cards. Students match the animal to the adaptation and place it under "Arctic" or "Desert"
  - Optional Hands-On Additions**:**
    - Faux fur swatches for Arctic animals

        - A plastic water bottle wrapped in fabric to simulate blubber (feel how slowly it loses heat compared to a bare one)
        - Plastic ears of different sizes (e.g., paper fan for fennec fox ears) to "feel" heat loss with a fan

Station 2: "Geo Detective" – Soil & Rock Samples

- **Materials:**
    - Real or replica samples of:
        - Arctic: permafrost (use frozen soil or clay), glacial rock (smooth, eroded)
        - Desert: sand, sandstone, cracked dry soil
    - Arctic Soil/Rock Simulation:
        - Permafrost soil: Use frozen modeling clay or a plastic container filled with wet soil frozen overnight (if allowed in your space). Wrap in foil and let them "touch" the top
        - Glacial rock: Use smooth river stones (to simulate glacial erosion), placed on ice packs to simulate cold
        - Snow or ice: Use packing peanuts, cotton balls, or fake snow (or crumbled Styrofoam)
    - Desert Soil/Rock Simulation:
        - Dry sand/soil: Use kinetic sand or dry play sand in trays
        - Cracked earth: Mix cornstarch and water, let dry in thin layers to simulate cracked clay
        - Desert rocks: Use porous pumice stone or red-painted gravel to simulate sandstone
    - Magnifying glasses, brushes, gloves
    - Station 2 instructions
- **Student Task:**
    - Examine and describe differences in soil and rock types
    - What might erosion or wind do in each place?
    - Match geological processes (e.g., freeze-thaw vs. wind erosion)

Station 3: "Survivor Challenge" – Ecosystem Builders

- **Materials:**
    - Use the Station 3 Cutout Cards or toy models of plants, animals, and other physical features (e.g., cactus, polar bear, igloo, sand dune)
    - 2 small poster boards labeled "Arctic" and "Desert"
    - Station 3 instructions
- **Student Task:**
    - Work as a team to **build a small ecosystem collage** on each board using correct items.
    - Three twist items belong in *both*. Can they guess which and why?
    - Draw a representation of the collages in the Student Handout.

Station 4: "Human on the Edge" – Survival Decisions

- **Materials:**
    - Station 4 Scenarios and Survival Items
    - Station 4 instructions
- **Student Task:**
    - Pick 3-5 survival items for each survival scenario and explain why.
    - Record responses in the Student Handout
    - Bonus: What modern tech would help humans survive there?

Mars Comparison (20 minutes)

Compare & Contrast

Students complete a three-way Venn diagram comparing Arctic, Desert, and Mars environments in the Student Handout.

Categories to compare:

- Temperature ranges
- Water availability
- Atmospheric conditions
- Geological features
- Life forms present
- Human survival challenges

Show the three mystery images from the introduction again. Highlight how both deserts and Arctic regions mirror **Mars' environment**:

  - Dryness, temperature extremes, isolation, low biodiversity
  - Devon Island (Canada) is rocky, barren, and cold – similar to Martian terrain
  - Utah's desert has red rock, dry climate, and visual resemblance to Mars

Discussion Questions:

1. Which Earth environment is more similar to Mars? Why? *Answers may vary.*
2. What makes both Earth environments useful for Mars training? *Both environments are useful because they help scientists practice living in extreme places. Since Mars is cold, dry, and has rough land, testing equipment and spacesuits in deserts or cold places helps us get ready for what it might be like on Mars.*
3. What are the biggest differences between Earth and Mars? *Mars has a much thinner atmosphere, so people can't breathe the air there. It's also way colder than Earth and has less gravity. Mars doesn't have liquid water on the surface like Earth does, and there are no plants or animals living there.*
4. Which simulations would you prefer to visit if you were preparing to actually visit Mars? *Answers may vary.*

Discussion Recap

Wrap-Up Discussion Prompts:

- Which environment would be harder to survive in and why?
- Did you notice any **surprising similarities** between the Arctic and desert?
- How do you think **Mars** compares to both?

Extension

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

CA NGSS Standards

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

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems

MS-ESS1-3: Develop a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations

MS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

CTE Alignment

2.1 Use effective communication skills
2.3 Understand the role of environmental and human factors in engineering design
2.4 Understand the role of troubleshooting in problem solving and product development
5.1 Apply engineering design process to solve problems
5.3 Use industry standard practices and processes to complete projects
11.1 Apply scientific principles to engineering problems

Resources

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