

SHOULD HUMANS LIVE ON MARS?



Exploring the Ethics of Space Exploration

OVERVIEW

As scientists learn more about Mars, an important question has emerged: Should humans establish permanent settlements on the Red Planet? There is no single correct answer. Scientists, engineers, policymakers, environmentalists, medical professionals, and community members all bring different perspectives to this conversation.

In this lesson, students examine multiple viewpoints about the future of Mars through a collection of argumentative essays that explore scientific, ethical, economic, environmental, and societal issues related to Mars exploration. Students learn that complex scientific questions often require balancing evidence with human values, priorities, and responsibilities.

Rather than debating to "win," students work collaboratively to understand multiple perspectives before participating in an International Mars Summit, where they represent delegates with different backgrounds, experiences, and priorities. Together, students develop recommendations for future Mars exploration before writing their own evidence-based argumentative essay.

Estimated Time: 4–5 class periods (45–60 minutes each)

LEARNING OBJECTIVES

Students will be able to:

- Analyze multiple arguments related to human exploration and settlement of Mars.
- Identify claims, supporting evidence, and reasoning within argumentative texts.
- Evaluate the strengths and limitations of different perspectives using evidence.
- Participate respectfully in collaborative discussions by listening, questioning, and responding thoughtfully.
- Consider how scientific decisions affect people, communities, cultures, and the environment.
- Develop recommendations based on multiple sources of evidence.
- Write an argumentative essay supported with evidence from multiple texts.
- Reflect on how different experiences, priorities, and values influence decision-making.

ARIZONA LANGUAGE ARTS STANDARDS

Reading Informational Text

- RI.6.1, RI.7.1, RI.8.1: Cite strong textual evidence to support analysis.
- RI.6.8, RI.7.8, RI.8.8: Trace and evaluate arguments and specific claims.
- RI.6.9, RI.7.9, RI.8.9: Compare ideas presented across multiple texts.

Writing

- W.6.1, W.7.1, W.8.1: Write arguments supporting claims with clear reasons and relevant evidence.
- W.6.9, W.7.9, W.8.9: Draw evidence from informational texts.

Speaking and Listening

- SL.6.1, SL.7.1, SL.8.1: Engage effectively in collaborative discussions.
- SL.6.4, SL.7.4, SL.8.4: Present claims and findings clearly using appropriate evidence.

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ARIZONA SCIENCE STANDARDS

Core Ideas for Using Science (all grades)

- U3: Applications of science often have positive and negative ethical, social, economic, and political implications.

6th Grade

- 6.E2U1.7: Use ratios and proportions to analyze and interpret data related to scale, properties, and relationships among objects in our solar system. (Students discuss Mars as a planetary destination and compare it with Earth while considering human exploration and settlement.)

8th Grade

- 8.EIU3.8: Construct and support an argument about how human consumption of limited resources impacts the biosphere. (Several essays ask students to consider whether humanity should invest resources in Mars exploration versus solving problems on Earth first.)

ARIZONA SOCIAL STUDIES STANDARDS

- **6.SP2.1, 7.SP2.1, 8.SP2.1:** Explain multiple perspectives on an issue using evidence to support claims and arguments.
- **6.SP3.1, 7.SP3.1, 8.SP3.1:** Gather, interpret, and evaluate information from multiple sources.
- **6.SP4.1, 7.SP4.1, 8.SP4.1:** Construct and support arguments using evidence from multiple sources.

ARIZONA CAREER EXPLORATION STANDARDS

- **1.1:** Distinguish among occupations, jobs, careers, and career pathways.
- **1.3:** Research knowledge, skills, and abilities needed for employment in each career cluster.
- **1.4:** Evaluate personal values, aptitudes, and interests, and explain how they influence career decisions.
- **3.1:** Give examples of critical thinking strategies/techniques.
- **3.3:** Investigate problem-solving and critical-thinking processes and techniques to meet real-world challenges and personal decisions.
- **4.1:** Identify collaborative skills needed to achieve a common goal.
- **4.3:** Practice behaviors that facilitate collaboration with peers.
- **5.5:** Use effective cross-cultural communication skills in person and virtually with diverse groups.
- **6.5:** Identify ethical issues in technology.
- **7.1:** Define accountability and ethical behaviors and discuss their importance in the workplace.

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MATERIALS

For each Student:

- For Activity 2: copies of the Mars Ethics Essays ("pro" and "con" essay for each topic):
 - Ecological Preservation of Mars
 - Governance of Mars
 - Human Health Beyond Earth
 - Mars: Humanity's Backup Plan
 - The Cost of a New World
- Highlighters
- Pencil
- Note paper
- For Activity 3: Mars Summit Delegate Profiles

Teacher Materials:

- Whiteboard or projector
- Chart paper
- Sticky notes

BACKGROUND KNOWLEDGE

Before beginning this lesson, students should understand:

- Mars is a neighboring planet that scientists continue to explore.
- Scientists have sent robotic spacecraft to Mars but humans have never visited.
- Scientists continue searching for evidence that Mars may once have supported life.
- Ethical questions often involve more than one reasonable answer.
- Good decisions are made by considering evidence alongside multiple perspectives.

Teachers may wish to spend five minutes introducing current Mars exploration before beginning the lesson, but extensive scientific background is not necessary because the essays provide the information students need.

VOCABULARY

Ethics: Thinking about what is right or wrong.
Claim: The main idea or position an author wants readers to believe.
Evidence: Facts, examples, or information that support a claim.
Counterargument: A different point of view that challenges a claim.
Perspective: A person's way of seeing or thinking about an issue.
Stakeholder: A person or group affected by a decision.
Consensus: An agreement reached by a group after discussion.
Policy: A plan or set of rules that guides decisions.
Delegate: A person chosen to represent others in discussions or decision-making.

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SETUP

Before class:

- Prepare one copy of each essay for every student.
- Arrange desks to encourage discussion.
- Display the warm-up prompt (below) before students arrive.

LESSON PROCEDURE

Warm-Up (20 minutes)

- As students enter, display the following prompt: *"Imagine people discover a place on Earth that has never been explored by humans. What should happen before people begin exploring, building, or living there?"* Students write independently for five minutes.
- Discuss answers in small groups or as a class.
- Ask students to brainstorm places that require careful decision-making before people develop them. (Possible examples include national parks, coral reefs, archaeological sites, rainforests, etc.)
- Discuss the benefits of exploring new places (learn new things, discover resources, advance science, create jobs, etc.)
- Discuss reasons for caution when exploring new places (wildlife/habitat destruction, pollution, damaging history or culture, etc.)
- Transition by conveying something like, "Throughout history, people have had to make difficult decisions about how to balance discovery with protecting people, cultures, and environments. Today, scientists and leaders face similar questions about Mars. Although no humans have permanently lived there, many organizations hope that someday they will. People are asking Should we go, and if we do, how should we do it responsibly?"

Activity 1 – Introducing the Five Questions (Optional, 20 minutes)

- Tell students: "There isn't just one question about living on Mars. Scientists, engineers, doctors, governments, and communities are discussing many different questions."
- Write these questions on the board (or display on your projector) one at a time, followed by a brief discussion:
 - Should humans protect Mars if it has life? What if it doesn't have life?
 - Who should make decisions about Mars? (Governments? Private companies? Whoever gets there first?)
 - Could living on Mars improve life on Earth? Consider medicine, technology, scientific discoveries, and new innovations.
 - Should Mars become humanity's backup home? (If Earth faces major disasters in the future, should humans prepare another place to live?)
 - Is spending money on Mars exploration worthwhile? (Should governments invest billions of dollars in Mars missions, or should those resources be spent solving problems here on Earth?)

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LESSON PROCEDURE

Activity 2 – Evidence Detectives (45-60 minutes)

- Tell students: "Throughout this lesson, you are not trying to prove that one side is completely right or completely wrong. Instead, your job is to understand the evidence, identify different perspectives, and think carefully before forming your own opinion."
- Introduce the five essays. Explain that each essay focuses on one important issue related to Mars exploration. Together, they present different ways people think about the future of Mars.
- Divide students into either 5 or 10 groups. If 5 groups, give each group both the "pro" and "con" essay for their topic. If 10 groups, separate the "pro" and "con" essay and give one to each group.
- Tell students that their group is the "expert" on their topic and will present the info to the class. They might consider highlighting the **claims** and the **evidence** in each essay.
- After students have had time to read and discuss the essay, have them present the topic to the class in whatever format you choose.
- Students who are not presenting should take notes and ask questions. Emphasize the importance of note-taking, as it will influence their ability to participate in the next activity!
- Optional: Have students take the essays home, read them, and add to their notes.

Activity 3 – Preparing for the International Mars Summit (20-30 minutes)

- Divide the students into groups of 2-4.
- Ask students to spend a few minutes reviewing and discussing the notes they collected during the group presentations.
- You might use these three points to guide the discussions:
 - The three strongest pieces of evidence they heard;
 - One argument they did NOT find convincing.
 - One question they still have about Mars exploration.
- You might choose to also discuss as a whole class before breaking into individual seating for the next exercise.
- Explain that every important decision affects different people in different ways. Scientists may focus on discovery, engineers may focus on safety, environmental scientists may focus on protecting Mars, while doctors may focus on astronaut health. Good decisions require listening to many perspectives before reaching a conclusion.
- Explain that for the next activity, each student will receive a Mars Summit Delegate Profile representing a person who has been invited to participate in the summit.
- Pass out one profile to each student and give them 5 minutes to read their profile.

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LESSON PROCEDURE

Activity 4 – International Mars Summit (45–60 minutes)

- Remind students: "Your delegate may have opinions that are different from your own. During today's summit, your goal is to represent your delegate respectfully while listening carefully to everyone else's ideas."
- Arrange students into summit groups of 5–8 delegates.
- **Introductions:** Each delegate introduces themselves by sharing:
 - their name;
 - their profession;
 - one thing that matters most to them regarding Mars exploration.
- **Topic 1: Opportunities**
 - Share the following prompt: What opportunities could human exploration of Mars create?
 - Encourage delegates to support their ideas with evidence from the essays whenever possible.
 - Possible discussion topics include scientific discoveries, technological innovation, international cooperation, protecting humanity's future, economic growth, medical advances. (You can use these topics to get groups going that are having trouble getting started.)
- **Topic 2: Risks**
 - Share the following prompt: What concerns should humanity consider before establishing a permanent settlement on Mars?
 - Remind delegates to use the opinions of their character profile, not their own personal opinions.
 - Possible discussion topics might include environmental protection, contamination, astronaut health, cost, governance, ethical responsibilities.
- **Topic 3: Changing Perspectives**
 - Remind students that changing one's opinion after considering new evidence is a sign of thoughtful decision-making.
 - Have delegates discuss and share any pieces of evidence that changed their mind.

Activity 5 – Writing a Mars Exploration Charter (30–45 minutes)

- Each summit group will create a "Mars Exploration Charter" that outlines the principles they believe should guide future human exploration of Mars.
- Remind students that different summit groups may create different charters, and that this reflects the complexity of real-world decision-making.
- The charter should include six to eight recommendations supported by evidence discussed during the summit.

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LESSON PROCEDURE

- If a particular group is struggling, you might prompt them with some of these questions:
 - What should happen if scientists discover evidence of life?
 - Who should help make decisions about Mars exploration?
 - What should we keep in mind before building anything permanent on Mars?
 - How can we keep astronauts safe and healthy?
 - What rules should astronauts follow to avoid harming the Martian environment?
 - How should governments decide whether to spend money on Mars exploration?
 - Should scientific discoveries made on Mars be shared with all countries? Why or why not?
 - If people eventually live on Mars, what rights should they have?
- Encourage groups to explain the reasoning behind each recommendation, especially if they finish before the other groups.
- You might consider adding additional time for students to present their recommendations to the class.

Culminating Writing Assignment (45-60 minutes)

- Tell students that they have now examined multiple perspectives, discussed evidence with others, and developed recommendations through the Mars Summit.
- Using everything they have learned, students will write an argumentative essay responding to the following prompt: "Should humans establish permanent settlements on Mars?"
- Students may support either position, provided they use evidence from the readings, discussions, and Mars Summit recommendations.
- Their essay should include:
 - A clear claim
 - Evidence from at least three of the Mars Ethics Essays
 - Acknowledgement of at least one opposing viewpoint
 - An explanation of why their evidence supports their conclusion.

EXTENSIONS AND TAKE HOME ACTIVITIES

- Invite students to research a Mars-related career. Refer to the Career Cards found on the AABC website for ideas. (<https://astrobiology.arizona.edu/your-mission-space>)
- Future News Report: Imagine it is the year 2055. Scientists have just made an important discovery or reached an important decision about Mars. Students write a newspaper article or television news script describing:
 - What happened?
 - Why is it important?
 - How did people react?
 - What might happen next?