

The Ethical Void: AI in Space Exploration

Why?

This lesson underscores the critical role of artificial intelligence (AI) in advancing space exploration, highlighting how AI enhances mission capabilities and introduces complex ethical dilemmas that require careful consideration. By examining the integration of AI in space missions alongside the ethical guidelines that govern its use, students gain insights into the challenges and responsibilities of navigating the final frontier with advanced technology. The lesson emphasizes the importance of balancing technological innovation with ethical integrity, ensuring that as we explore the cosmos, we remain guided by our values and the broader implications of our decisions for humanity's future in space.

Materials Needed

- Simulation handout for student groups

Time needed

- Approximately 45 minutes

Objectives

- Students will be able to identify and describe ethical considerations and dilemmas that arise with the use of AI in space missions, drawing parallels to similar ethical challenges on Earth.
- Students will be able to evaluate the importance of programming ethical guidelines into AI systems, especially in high-stakes environments like space exploration.
- Students will be able to analyze scenarios where AI must make critical decisions in space exploration, considering the potential risks and benefits of those decisions.

Key Concepts & Vocabulary

- **Artificial Intelligence (AI):** Machines designed to perform tasks that typically require human intelligence.

Lesson Components

1. **Before You Watch:** Connect lesson to history of computers in space exploration and prime students to watch the video
2. **Video:** Show the pedagogy.cloud video explaining the ethical considerations in the topic of AI in space exploration
3. **Case Study:** Detail a real-world scenario that relates to the issue of AI making decisions that may impact astronauts' lives and safety
4. **Simulation:** Lead students through an interactive activity exploring the possible ethical considerations
5. **Discussion:** Ask whole-class questions to reflect on experience and consider perspectives.

6. **Assessment:** Verify student understanding with an exit ticket

1. Before You Watch

Historical Tech Comparison

Provide some details comparing the technology used in the early space missions (e.g., Apollo's onboard computer) with today's smartphones and pocket calculators. Highlight the exponential growth in computational power since the 1960s, setting the stage for a discussion of AI's role in modern space exploration.

Basic information presented below.

Additional context and more examples here:

<https://apollo11space.com/mobile-phone-vs-apollo-11s-guidance-computer/>

Feature	Apollo missions	Modern smartphone
Clock speed	0.043 MHz (megahertz)	3.23 GHz (gigahertz - 120 million times faster)
Weight	70 pounds	5 ounces
Size	1 cubic foot	Fits in your hand
Memory	64 KB (kilobites)	64 GB (gigabites - 1 million times greater)
CPU speed	1.024 MHz	GHz (clocked in Gigahertz - approx. 3200 times faster)

While You Watch: Mention these topics and questions for students to look out for as they watch the video:

- What advancements in technology have allowed modern space missions to rely heavily on AI?
- In what ways does AI act as a 'crew member' on space missions? Find at least two examples from the video.
- Describe how AI systems can become the 'eyes, ears, and hands' of human explorers in space.

2. Video Summary

The video explores the transformative role of artificial intelligence (AI) in space exploration, from enhancing mission capabilities to facing ethical dilemmas that challenge the integration of technology with human values. It highlights the evolution from basic onboard computers of the past to sophisticated AI systems that act as indispensable crew members, navigating, analyzing, and making critical decisions in space. The narrative culminates in the reflection that as humanity reaches out into the cosmos, guided by AI, the essence of space exploration lies not just in the destinations we aim for but in maintaining our ethical compass, ensuring our technological

advancements serve both our quest for knowledge and our fundamental human principles.

3. Case Study

Distribute or read Case Study handout.

Summary: In the “Lunar Greenhouse Dilemma” case study, an AI-controlled lunar colony faces a critical decision after a solar flare damages the colony's infrastructure: prioritize repairing the AI-managed greenhouse, crucial for advancing space agriculture, or focus on fixing the colonists' living quarters for immediate safety and comfort. This scenario highlights the ethical challenges of balancing short-term human needs against long-term scientific benefits in space exploration. Students are prompted to consider the role of AI in decision-making, the prioritization of resources, and the impact of these decisions on the future of human space exploration.

4. Simulation

The simulation activity for this lesson puts students on a theoretical future Mars base.

1. **Brief the Students:** Start by explaining the context of the Mars colony and the crucial role AI plays in its management. Introduce the unexpected dilemma involving the agricultural dome and the research lab.
2. **Present the Scenario:** Detail the specific challenge the colony faces with the agricultural dome and research lab, emphasizing the importance of both and the impossibility of saving both due to environmental conditions.
3. **Group Formation:** Divide the students into groups of about 4 and distribute the Simulation Handout
4. **Role Assignment:** Have each student choose a role within their groups: Colony Leader, Agricultural Specialist, Chief Scientist, and AI Programmer.
5. **Individual Assessment:** Allow time for each student to consider the scenario from their assigned role's perspective, noting key points and arguments.
6. **Group Discussion:** Have each group discuss their initial thoughts and perspectives, sharing insights and concerns related to their roles.
7. **Decision Framework:** Have groups discuss how they would program the AI to make such decisions, considering the ethical implications and potential for similar future dilemmas. Each student presents their role's viewpoint on what decision should be made, supporting their stance with ethical reasoning and practical considerations. (For example, some groups may state that preserving the scientific data is most important, even if all of the humans die. New humans can be sent to the base, but the data cannot be recovered otherwise.)
8. **Alternative Solutions:** Encourage groups to think creatively and propose any additional ideas, options, or compromises that could mitigate the impact of the loss on either side of the dilemma.
9. **Group Presentations:** Have each group share their decision, the ethical reasoning behind it, and any alternative solutions they discussed.

5. Discussion

These questions are designed to be used in whole-class discussion. Ask questions that relate most effectively to the lesson.

1. What ethical principles did you consider when making your decision in the simulation?
2. How did assuming different roles within the Mars colony affect your viewpoint on the dilemma? Did any role change your initial perspective on what decision should be made?
3. Can AI truly make ethical decisions, or is it merely following programmed instructions?
4. Given the limitations of AI in understanding human values and ethical nuances, what role should human oversight play in AI decision-making?
5. How do the decisions made by AI, especially in critical scenarios like this simulation, affect the long-term sustainability and ethical integrity of a community or society?
6. Can you think of any real-world situations where similar ethical dilemmas have arisen, particularly involving technology or AI?

6. Assessment

Exit Ticket: Provide a prompt for students to reflect on their learning, such as:

- Summarize how artificial intelligence (AI) is used in modern space missions and give two specific examples mentioned in the video.
- Explain the significance of integrating ethical guidelines into AI systems, especially in the context of space exploration. Why is this necessary?
- How does the advancement of AI in space exploration challenge our traditional understanding of exploration and discovery?

Sources to Learn More

- 2021 NASA report on the topic of the ethical use of AI in space exploration: <https://ntrs.nasa.gov/api/citations/20210012886/downloads/NASA-TM-20210012886.pdf>
- As linked above in “Before You Watch,” a comparison between Apollo 11’s computers and modern technology: <https://apollo11space.com/mobile-phone-vs-apollo-11s-guidance-computer/>
- 2023 article in the publication “Philosophy & Technology” detailing expected challenges related to the use of AI in space exploration: <https://link.springer.com/article/10.1007/s13347-023-00626-7>

Case Study: Lunar Greenhouse Dilemma

In the not-too-distant future, humanity has established a small but thriving research colony on the Moon. At the heart of the colony is an advanced AI-controlled greenhouse, designed to study and produce genetically modified plants capable of thriving in extraterrestrial environments. These plants are not only crucial for providing food to the lunar colonists but also for future space missions to Mars and beyond. The AI, named LunaBot, is tasked with optimizing plant growth and ensuring the greenhouse's success.

LunaBot is equipped with state-of-the-art technology, capable of monitoring plant health, adjusting environmental conditions, and even experimenting with new plant varieties. The greenhouse serves as a vital research facility, contributing to scientific knowledge about sustainable life support systems in space.

However, the lunar colony faces a dilemma when an unexpected solar flare damages several colony modules, including the greenhouse. LunaBot must now make a critical decision: prioritize the repair of the greenhouse to save the plants, which are on the brink of a breakthrough that could significantly advance space agriculture, or divert resources to repair living quarters, risking the plants but ensuring the colonists' safety and comfort.

The dilemma presents several ethical concerns:

Prioritization of Human Needs vs. Scientific Progress: Should LunaBot prioritize immediate human needs over long-term scientific benefits?

Responsibility of AI in Decision-Making: Given LunaBot's capabilities, should it make decisions affecting human welfare and scientific progress, or should such decisions be reserved for humans?

Impact on Future Missions: The potential breakthrough in space agriculture could revolutionize future space missions, making sustainable life support systems more feasible. Losing this opportunity could set back space exploration efforts.

Should LunaBot prioritize the greenhouse, or life support?

Reflective Questions

- If you were a lunar colonist, would you agree if LunaBot decided to prioritize the greenhouse? Why or why not?
- How should AI be programmed to balance short-term human needs with long-term scientific goals?
- Is it ethical to allow AI to make decisions that could have significant impacts on human welfare and scientific progress?
- Can a compromise between human needs and scientific advancement be justified in such scenarios? What would be the ideal outcome?

Simulation Activity: Mars Colony Emergency

The Mars colony faces an unprecedented situation where the AI system, designed to manage the colony's resources and ensure safety, encounters a scenario not covered by its existing programming. Two critical systems are at risk due to unexpected environmental conditions: The colony's agricultural dome, which houses genetically modified crops crucial for future food supply, and a research lab containing irreplaceable alien specimens that could hold the key to understanding life beyond Earth.

The dilemma arises because saving one would unavoidably lead to the loss of the other. The agricultural dome ensures the colony's long-term sustainability and food security, while the research lab has the potential to revolutionize scientific understanding and could lead to breakthroughs in technology, medicine, and the understanding of life in the universe.

Roles

Colony Leader: Responsible for the welfare and future of the colony.

Agricultural Specialist: Advocates for the importance of food security and sustainability.

Chief Scientist: Emphasizes the unique value and potential of the alien specimens.

AI Programmer: Understands the AI's decision-making capabilities and limitations.

Your group will debate how to program AI for such ethical dilemmas, considering various ethical frameworks and the potential for unforeseen circumstances.

Each person presents their argument from the perspective of their role, and the group must reach a consensus on what action to take, justifying their decision based on ethical reasoning.

What did your group decide? How should the AI be programmed?

What is your justification for this decision?

How did you come to this conclusion?

Video Script for Animator

Hello Young Innovators! Today we're discussing the ethics of AI in space exploration.
Title screen

Look around. You're gazing into the vastness of outer space, a setting for boundless possibilities of exploration.

[Socrate narrating throughout, facing viewers.
Scene opens looking up into a field of stars in the night sky. Pan down to see Socrate looking through a telescope. Example image: <https://i.imgur.com/2f8YBuT.jpeg>]

In the early days of the space program, the computers onboard spacecraft were less powerful than a modern cell phone. But today, space missions are propelled by cutting-edge advancements, harnessing the unparalleled capabilities of artificial intelligence.

[Socrate turns away from the telescope to face the viewer, pulls out a cell phone when the phone is mentioned. At the end, he takes a selfie of himself with the sky in the background. The phone's camera flash goes off. Example image: <https://i.imgur.com/Ro554uz.jpeg>]

AI is not just a part of science fiction; it's a crucial crew member on today's space missions, helping navigate, analyze, and make decisions millions of miles from Earth.

[Scene shifts to what looks like the inside of a space station. Socrate wearing an astronaut's outfit. Computer screen showing images of AI systems controlling vital systems on the space station. Example image: <https://i.imgur.com/CXo3j1i.jpeg>]

In the vast expanse of space, AI systems become the eyes, ears, and hands of human explorers. They manage everything from navigating through asteroid fields to analyzing alien soil samples, and even predicting equipment failures before they happen.

[Socrate looks out the window of the space station and the shot zooms through the window to see a rocket deftly maneuvering through an asteroid belt guided by AI. Example image: <https://i.imgur.com/fVM6QGb.jpeg>]

But what happens when AI faces a decision that could risk the mission or even lives? Imagine a scenario on a distant space station where an AI must choose between saving vital research data or ensuring the crew's safety during a solar flare.

[Visuals of a tense situation on a space station with incoming solar flare alerts. The AI interface is shown weighing options: On a computer screen are two images representing research and the crew. Example image: <https://i.imgur.com/016SI0L.jpeg>]

This is where ethics comes into play. Programming AI with ethical guidelines ensures that, even in the vastness of space, our values guide the decisions made at the speed of light.

[A computer programmer writing code with symbols like scales of justice, green checkmarks and red X's swirling around the computer monitor. Example image: <https://i.imgur.com/n4EpGFB.jpeg>]

Ethical dilemmas in space aren't just theoretical. They happen every day in life-or-death environments in space. Some argue that the potential scientific gains outweigh the risks, pushing the boundaries of what we know about the universe. Others believe that no discovery is worth danger to human lives.

[Two groups of scientists and engineers in a heated debate, with holographic displays of space floating between them. Example image: <https://i.imgur.com/4eGYIO4.jpeg>]

As we venture further into space, guided by AI, these ethical considerations become more than just programming challenges. They become reflections of our humanity, stretched across the stars.

[A diverse crew on a spacecraft looking out at the cosmos, with the AI interface among them, displayed as a constellation shaping ethical symbols. Example image: <https://i.imgur.com/eNfpdOj.jpeg>]

In the vast, uncharted expanses of space, AI and ethics guide us, ensuring that as we reach for the stars, we remain grounded in our values. The future of space exploration is not just about where we can go, but about who we choose to be along the way.

[Socrat standing with a launch pad in the background. As he talks, the rocket blasts off behind him. He turns around and looks at it. Example image: <https://i.imgur.com/m40TxtN.jpeg>]

As we navigate this journey, blending technology and ethics to explore the unknown, let's always be mindful of the delicate balance between advancing our knowledge and keeping people safe.

[The video closes with the spacecraft approaching the Earth-like planet, symbolizing the future of space exploration. Green glowing lights on the spacecraft symbolize AI guidance. Example image: <https://i.imgur.com/55e7v14.jpeg>]

Let's discuss: Imagine you are part of a space mission guided by AI. What qualities would you want the AI to have, and why?

[Display question on screen at end of video: Imagine you are part of a space mission guided by AI. What qualities would you want the AI to have, and why?]

Video Script for Narrations

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