Elementary School Engineering Lesson
AI in Aerospace

AEROSPACE | STEM

Lesson Overview	Career Highlight
Students will be introduced to different types of artificial intelligence and machine learning algorithms, including those used to operate space-based platforms (such as satellites). Students will then learn about jobs relating to the building and continuous improvement of machine learning tools. Throughout this lesson, students will be engaged in mini activities that include learning about coding, problem solving, and working in teams to build their communication skills. By the end of the week, students will play an interactive game to save the world! In teams, students will take on the roles of engineers and scientists to identify and solve anomalies and errors encountered by a deployed satellite system. Together, students will resolve these errors, assigning them to the right STEM professional (see career highlight) to make sure that critical data collected by the satellite are sent back to Earth to be used in making high-consequence decisions.	**Guidance, Navigation and Control Engineer**: Designs, manufactures, and tests systems for aircraft/spacecraft. **Flight Dynamics Officer/ Engineer**: Responsible for trajectories, flight paths, and orbital mechanics. Makes sure all parts follow the correct path and physics. **Systems Engineer**: Works with all teams, manufacturers, and designs to ensure product works as advertised. **Communication Engineer/ Specialist**: Researches and designs methods of communication in space with Earth. **Computational Analyst**: Calculates how much memory, data, and what type of data/computer processing will be needed for scenarios.

STEM Course Connections	21st Century Skills
Computer Science Science Technology	Collaboration Communication Critical Thinking Technology Literacy

Materials
● Day 4 & 5 Game- Scenario with directions (Print per group) ● Error coded messages (Print per group & sort) ● Large Envelopes ● Paper ● Pencil

- Reading Article, (Inserted in daily procedures)
- Student Handout
- Video resources, (Inserted in daily procedures)

Essential Questions

1. What is Artificial Intelligence? Is machine learning just another word for the same thing?
2. What careers are centered around the development and control of AI and machine learning?
3. Why is AI important to me? What do I use day-to-day that depends on AI and machine learning?
4. How is AI used in space, specifically with satellites?

Prerequisite Knowledge

Concepts developed in a previous lesson, Robotic Satellites K-3, may help students with understanding this lesson, but it is not a necessary prerequisite lesson.

Day 1: *Where is A.I.*

Section A - What is Artificial Intelligence? (10 mins)
- Teachers will start the lesson by asking students the following introduction questions:
    1. Have you heard the words Artificial Intelligence or A.I.? *Answers will vary.*
    2. What is A.I.? *Artificial Intelligence is the science of making machines (like computers or robots) think like humans.*
    3. *Can you list things in your life or household items that you interact with that might utilize AI? Alexa, Siri, Google Maps, Uber/Lyft, Email, Watches, Vacuum, Thermostats, Fitness Mirror, Video games, Ring Camera, Social media, chatbots, etc.*
- After the introductory conversation, teachers will explain to students that Artificial Intelligence is the science of making machines, like computers or robots, "think" like humans. Humans process data to make predictions or do something useful, and we can train a computer to do the same.
- Teachers will then show students a short video on the definition of A.I.

Section B - What is Machine Learning? (5 mins)
- Teachers will lead a group discussion on the term Machine Learning. Teachers will then ask students the following guided questions.
    1. Have you ever heard of Machine Learning? *Answers will vary.*
    2. Do you think it is the same as A.I., or do you think A.I. uses Machine Learning? *Answers will vary.*
- After the guided conversation, teachers will guide students to the following statement of what Machine Learning means.

Teacher Note: Machine Learning is a subfield of A.I. Just like students in school, machines are given directions, lessons, and answers to questions in order to one day be able to think on their own. Computers and robots can learn to "think" on their own by analyzing data and memorizing algorithms. This video may be helpful, and this gives an example of weather prediction.
- Teachers will then show students a short video to clarify the difference between A.I. and Machine Learning.

Section C - Mini-Activity: "Where is A.I.?" (10-15 mins)
- Teachers will hand out the Student Handout for Day One, "Where's A.I.?!" Students will answer questions independently, in small groups, or as a class for Section C.
- Teachers will prompt students to think about times they have encountered A.I. or Machine Learning in

their own lives. The objective is for students to provide examples of objects that use A.I. & Machine Learning both inside and outside of school.

1. What are some examples of A.I. or Machine Learning that you have seen in school? *Facial recognition on iPads, Chat GPT*
2. What are some examples of A.I. or Machine Learning that you have seen at home? *Alexa, Siri, Self-Driving Cars, Google Maps, Uber/Lyft, Email, Watches, Vacuum, Fitness Mirror, Video games, Thermostats, Ring Camera, Social media, chatbots, etc.*

● Teachers will have students share and discuss their answers.

Day 2: *How do Satellites "Wave?"*

In this lesson, students will explore how satellites communicate with Earth from space. Students will learn about how satellites orbit, types of satellites, and will draw wave-lengths to understand how information is shared back and forth.

Section D - What is a Satellite? (10 mins)
● Teachers will guide students in a group discussion on the following questions.
1. What is a Satellite? *Things that orbit the earth/something that orbits something else in space.*
2. Do all Satellites look alike? *No!*
3. Are all Satellites made by humans? *No. Example: the moon*
4. What is the purpose of Satellites? *Communication, navigation, spying, etc.*
● After the guided conversation, teachers will have students watch a short video to introduce them to Satellites.

Section E - Communication with Satellites (5 mins)
● Teachers will use the following guided questions to continue the conversation and discuss how satellites communicate with Earth, and why we use satellites.
1. How do we "talk" to Satellites? *By using radio signals.*
2. What kind of information do we retrieve from satellites? *Any form of data.*
● After the guided conversation, teachers will have students watch this short video to explain how satellites communicate with Earth.

Section F - Mini-Activity: How do Satellites Wave? (10 mins)
● Teachers will direct students to fill in the blank sections of the image below on the Student Handout Section F.
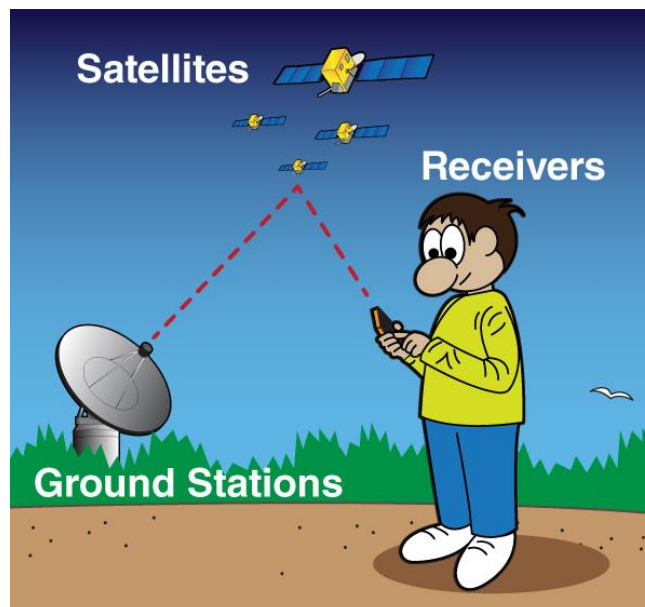
- Teachers will then ask students what are two ways that the students have used satellite communication in their personal lives, have students write their answers in the [Student Handout] Section C and then ask them to share their answers. *GPS, satellite TV, WiFi, etc.*

Day 3: *I Wear Many Hats*

In this lesson, students will explore engineering jobs that utilize A.I. to communicate with satellites. Students will learn about each type of job and how these jobs work together to help design, improve, and maintain Satellite communications. Students will also learn how A.I. is a helpful tool and thought of as a "co worker" and part of the team!

Section G - What is an Engineer? (10 mins)
- Teachers will guide students in a group discussion about the following questions.
    1. Do all Engineers solve the same problems? *No.*
    2. What types of skills would engineers need to be able to work together effectively? *Communication, problem-solving, Patience, etc.*

Section H - Introduction to Engineering Jobs (10-20 mins)
- Teachers will guide students in summarizing the following examples of related STEM careers in [this article].
- Teachers will then lead students in a brief discussion of the following STEM jobs that work together to maintain, build, control, and design satellite communications with the use of A.I.
    - **Guidance, Navigation and Control Engineer**: Designs, manufactures, and tests systems for aircraft spacecraft.
    - **Flight Dynamics Officer/ Engineer**: Responsible for trajectories, flight paths, and orbital mechanics. Makes sure all parts follow the correct path and physics.
    - **Systems Engineer**: Works with all teams, manufacturers, and designs to ensure product works as advertised.
    - **Communication Engineer/ Specialist**: Researches and designs methods of communication in space with Earth.
    - **Computational Analyst**: Calculates how much memory, data, and what type of data/computer processing will be needed for scenarios.

Section I - Match that Engineer! (10-15 mins)
- Teachers will have students complete Section I of the [Student Handout] (Answers identical to the descriptions above). Students may work together, individually, in small groups, or as a whole class.
- Once completed, teachers will show students one [final video] on a job centered around satellites.

Day 4 & 5: *Solve the Code. Save the World!*

Throughout this week, students have gained knowledge about A.I., Machine Learning, and how satellites communicate. They have also learned about the STEM professions that design, improve, repair, and work together to maintain our satellite communication. Today, students will work in small teams, and will be given a story plot to save the world! Each team will use their [Student Handout] to guide their progress through the coding activity. Students will work together to solve all three error codes to restore lost communication with a satellite. Are your students up to the task?

Section J - Vocabulary Development (15 mins.)
- Building on the first 3 days, students will formalize their understanding of vocabulary words in Section J of the [Student Handout].
    - **Artificial Intelligence, (A.I.):** *The science of making machines (like computers or robots) think like humans.*
    - **Machine Learning:** *A subset of A.I that involves teaching a machine how to think.*

    ○ **Satellite:** *A man-made or natural object that moves around a larger object.*
    ○ **Orbit:** *The curved path of an object around a large mass, such as a star or planet.*
    ○ **Ground Station:** *A technological station placed on Earth to collect and stream satellite data.*
    ○ **Receiver:** *The destination that receives the communication or data from the satellite.*

Section K - Introduction to Solve the Code Game (5 mins.)
● Teachers will place students in small groups to work through the code game together.
● Teachers will present the directions and read the scenario as a class.

Teacher Note: One person should be designated the "A.I. in room". This should either be the teacher, or an individual capable of checking all students' work. This individual will also be in charge of the answer key.

Section L - Play the Game! (20-30 mins.)
● Students will record the error and the correction for each of the 4 error codes in Section M of the Student Handout.
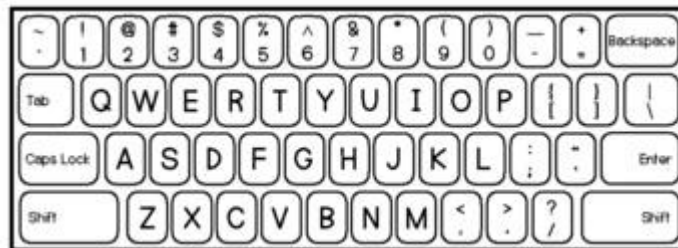● Answer Key: *Be sure to share this with the "A.I. in room" if not the teacher*

Code 1:

<div align="center">

12#34%56&78*90

Answer: The * is the error in code.

Correct code: 12#34%56&78(90

12[shift 3 = #]34[shift 5 = %]56[shift 7 = &]78[shift 9 = ( ]90

</div>

Code 2:

<div align="center">

💙🌻 + 💐🐕 = ?

52 + 89 = 141

🌀🌵 / 🌀 = ?

14 / 1 = 14

🐼🍉 X 🌻 = ?

36 x 2 = 72

</div>

1	2	3	4	5	6	7	8	9
🌀	🌻	🐼	🌵	💙	🍉	🦕	💐	🐕

Code 3:

<div align="center">

Message: OCEJKPG NGCTKPI

Answer: Machine Learning

</div>

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B

Error Message: Oops, message has been intercepted! Send a decrypted message to grant access.

Caesar Cipher: A type of cipher that shifts letters in a message to make it unreadable if intercepted. To decrypt, reverses the shift.

2 letter shift : K=I

Section M - Debrief of Game (15 mins.)
● The instructor will go over the answer key with students.
● The instructor will conclude the lesson with the following guided questions-
    1. Was your team able to solve all codes? *Answers will vary.*
    2. What were your team's strengths? Weaknesses? *Answers will vary.*
    3. Do you feel your team was able to communicate and collaborate together effectively? *Answers will vary.*
    4. How was the role of A.I. useful? What would have made it more useful? *It was useful because it identified correct or incorrect error codes. It could have been more useful if it told you why a specific code was an error.*

CA NGSS Standards
● [4-PS3-2](#)- Energy: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. ● [4-PS4-1](#)- Energy: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. ● [4-PS4-3](#)- Waves: Generate and compare multiple solutions that use patterns to transfer information. ● [5-PS2-1](#)- Motion & Stability: Support an argument that the gravitational force exerted by Earth on objects is directed down. ● [5-ESS2-1](#)- Earth's Systems: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Resources
Aerospace. (n.d.). STEM Profiles. https://aerospace.org/sites/default/files/2023-03/STEM%20profiles_0323pdf_0.pdf Argo's World. (2020, August 21). What is ARTIFICIAL INTELLIGENCE? - Argo's World | STEM for Kids (Science, Tech, Engineering, Math). https://www.youtube.com/watch?v=HdIppwUJ0f8 GCF Learn Free. (2018, February 22). *What is Machine Learning?*. YouTube. https://www.youtube.com/watch?v=QghjaS0WQQU

How to become a Computer Systems Analyst: A career analysis. GetEducated. (2022a, March 24). https://www.geteducated.com/career-center/detail/computer-systems-analyst/

Leetaru, K. (2019, January 15). *Why machine learning needs semantics not just statistics*. Forbes. https://www.forbes.com/sites/kalevleetaru/2019/01/15/why-machine-learning-needs-semantics-not-just-statistics/?sh=5fb9318077b5

NASA. (2019, June 27). *How Does GPS Work?*. NASA. https://spaceplace.nasa.gov/gps/en/

Orbit generic color omission icon. Freepik. (n.d.). https://www.freepik.com/icon/orbit_6989355

Parkes Observatory . Wikipedia. (n.d.). https://sk.wikipedia.org/wiki/Súbor:CSIRO_ScienceImage_4350_CSIROs_Parkes_

Radio_Telescope_with_moon_in_the_background.jpgReady Jet Go! (2023, December 7). *How Do Satellites Work?: Ready Jet Go!*. PBS LearningMedia. https://ca.pbslearningmedia.org/resource/ready-get-go-how-do-satellites-work/how-do-satellites-work-ready-jet-go/

Science Trek. (2020, November 2). *Satellites: The Story of Satellites | Science Trek*. YouTube. https://www.youtube.com/watch?v=_IiPMG43L54

Search the California Content Standards. CA Content Standards (CA Dept of Education). (n.d.). https://www2.cde.ca.gov/cacs/science?order=0&c3=1%2C2%2C4&perpage=10&mingrade=3&maxgrade=5&dl=0&page=3

Tomaswick, A. (2021, October 5). *It will soon be possible to make satellite phone calls with your regular phone*. Phys.org. https://phys.org/news/2021-10-satellite-regular.html

WPSU PBS. (2021, May 19). *Kyle Lucas, United States Space Force*. YouTube. https://www.youtube.com/watch?v=Zt04s3PdBws