Lesson Overview	Career Highlight
Students will continue their planning and design of a CubeSat prototype and corresponding project proposal to The Aerospace Corporation. They previously selected a human impact to study and learned how CubeSats can be used to collect data on their selected human impact. In this lesson, students will determine the specific CubeSat payloads they will need to accomplish their data collection. They will add these components to their CubeSat prototype and include their payload selection and justification in their project proposal to Aerospace. To finalize their learning, students will learn how their CubeSat will enter space and orbit the planet. They will finalize their project proposal and present their ideas to determine which research project will be selected for funding by Aerospace.	Software Developer (Aerospace Employee Ruben) Physicist (Aerospace Employee Christine) Aerospace Expert-career depends on who visits classroom

STEM Course Connections	21st Century Skills
Middle School Earth Science Middle School General Science	Critical Thinking Communication Creativity Collaboration

Science and Engineering Practices	
Asking questions & defining problems	Students will engage in asking questions about different human impacts on the planet. Then, they will think about how the issues in the questions can be monitored with data from space.
Constructing Explanations and Designing Solutions	Students will apply their understanding of human environmental impacts to design a cubesat satellite to monitor a specific example. They will also identify why it has value and develop a proposal for their project.

Materials

Teacher Notes: See Lesson 2: Student Handouts and Lesson 2: Teacher Resources for specific attachments.

Day 6 & 7
Payload Options Sheet from Student Handouts
CubeSat Payload Add-ons from Student Handouts
Payload Justification Grid from Student Handouts
Proposal Slide Template
Example - Initial CubeSat Prototype from Student Handouts

Day 8
How Will My CubeSat Orbit? from Student Handouts
Proposal Slide Template

Day 9
Proposal Slide Template
Video recording application

Day 10
Proposal Feedback Sheet

Essential Questions

How do you communicate your proposal to your team at Aerospace?

Day 6 & 7: What data needs to be collected to monitor the human impact and how will we collect this data?

Part 1: Reference to DQB (5 mins)
The teacher will begin the lesson by revisiting the DQB from Lesson One: Day One. Based on their learning about the value of space, and their CubeSat learning, students will cross off questions that were answered on their DQB. They will focus on remaining questions which may pertain to the type of data to be collected and what data will need to be collected. The teacher will circle or indicate that this lesson will be about "What data will be needed to monitor the human impact?"

Part 2: Determining the Data to Collect

1. Once students are ready, they will look through the possible payload options provided by the teacher on the Payload Options Sheet from Student Handouts. In addition to this sheet, they will have cutouts provided from the CubeSat Payload Add-ons from Student Handouts of possible payload components that they may search through and select from. They will use this to determine the appropriate components to add to their prototype. They will need to discuss with their team what data they need to collect to monitor their human impact, and which of the available payload options will help them meet this goal.

2. Students will use a Payload Justification Grid from Student Handouts to justify the components of their payload and how it will help them achieve their data collection goal to monitor human impacts.

Teacher Notes: To develop background knowledge on payloads, the Q&A on CubeSat Payloads: What Can You Put in a Small Satellite? by Alén Space can be helpful for the teacher. The list of payloads provided on the Payload Options Sheet is not an exhaustive list. Students may have ideas that are not listed on the Payload Options Sheet. They may research and include alternative payloads to include in their design process.

Part 3: Assembly of Prototype

1. Students will have their Payload Justification Grid checked by the teacher before proceeding onto the assembly of their prototype. The teacher should discuss with each group the goal of their data collection mission and verify that the payload selection is appropriate for their mission.
2. Each student group will add their payload to the design of their CubeSat prototype that they built on Day Five. Their CubeSat should have the components of their CubeSat platform already assembled.

3. Student groups will work with their Payload Justification Grid as well as the provided cutouts from the CubeSat Payload Add-ons to finalize their CubeSat prototype.
    a. Solar panels, antennae, and camera lenses must be on the exterior of their prototype.
    b. Additional platform and payload components will stack into their prototype, as seen in the images of the Example - Initial CubeSat Prototype from Student Handouts.

Part 4: Adding Information to the Proposal

1. When students have completed the Payload Justification Grid and assembled their prototype, they will add the information to the payload slides of the Proposal Slide Template. Students may include multiple slides depending on the payload options they have selected.

Day 8: How will my CubeSat orbit to collect the appropriate data?

Part 1: Introduction (5 mins)

To introduce the lesson, the teacher will remind the students that the goal is to figure out how to collect data from space, so we need to get the CubeSat into orbit. The teacher will ask students to activate prior knowledge and work together to come up with a definition of orbit (*Ex: the curved path an object takes as it moves around another object)*. The teacher will ask students for ideas of how the CubeSats get into orbit. This may have been covered in other lessons or discussions with the expert. The teacher can show the video How Do CubeSats Get Into Orbit? from NASA's Kennedy Space Center to finish the introductory discussion.

Part 2: Determining CubeSat Orbit (35 mins)

In order to simplify a somewhat complicated process, the students will complete an evidence-based approach to determine the orbit for the CubeSat to collect data. Students will complete the How Will My CubeSat Orbit? from Student Handouts alone and then will share their ideas with their team. Once the team has come to a consensus, they will add it to their slides. The sheet explains a specification of the orbit and then the students will choose the most appropriate specification for their goals and provide evidence from the reading and their project to support the "claim."

Teacher Notes: This would be a good opportunity to review text annotation reading strategies to help students identify appropriate evidence.

Part 3: Adding Information to Proposal (5 mins)

When students have completed How Will My CubeSat Orbit? and met with their group, they will add the information to the Proposal Slide Template. This may go into the next day depending on the students pace.

Day 9: How can you monitor human impacts with data from space? Finalize Proposal

Introduction (5 mins)
Teacher will introduce the requirements for the proposal. The teacher will remind students that proposals should be video recorded and should be less than three minutes in length. There are many apps that allow students' voices to be recorded while slides are presented. The teacher will remind students that they will be able to write a script, but should make sure they are using appropriate public speaking tone and inflection.

Finalize Proposal & Script (25 mins)
Students should finalize their proposal and the slides on their Proposal Slide Template. Depending on the number of students in the group, the slides will be divided among group members to ensure participation. Students should write the script for the slides that they are responsible for completing.

Proposal Recording (15 mins)
Students will record their proposal based on the application or videoing technology designated by their teacher.

Day 10: How can you monitor human impacts with data from space? Proposal

There are several options for this day depending on teacher goals and timing. See below for examples.

Example 1: Students can watch their classmates' proposals and provide feedback. That feedback can be used to change proposals and re-record the videos. Teachers can use the Proposal Feedback Sheet to guide student feedback.

Example 2: Students can watch their classmates' proposals and decide on the proposals that should be funded by Aerospace. Teachers could allow students to rank proposals based on requirements such as scientific accuracy, need, or other parameters. Highest-scoring proposals could be sent to Aerospace so they can decide which proposal to "support".

Example 3: Students can present proposals to an outside audience such as other classes or parents.

Example 4: Students could invite the Aerospace expert back into the classroom to share their pitches, or students could record their pitches and share these recordings with the Aerospace expert. The Aerospace expert can be involved with the selection process of which project gets "funded".

CA NGSS Standards

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

Extensions

An optional extension activity at this point in the lesson could be performing vibration or drop testing in the student CubeSats. CubeSats go through vibration testing to make sure they survive the launch process. Another optional extension can be for students to continue their human impact research and look into solutions to the human impacts they are monitoring with their CubeSats.

Value of Space Proposal Feedback Sheet

Group Name:

Directions: For each of the following categories below, indicate where the team falls by placing a dot or star on the continuum. Add comments and suggestions below the continuum or in the space provided at the end.

Human Impact	
• Is the human impact clearly defined?	**BIG YES** — **BIG NO**
• Can the human impact be monitored from space?	**BIG YES** — **BIG NO**

CubeSat Design & Orbit	
• Is the CubeSat "doable"?	**BIG YES** — **BIG NO**
• Is there evidence to support the chosen orbit?	**BIG YES** — **BIG NO**

BIG YES — **BIG NO**

Overall Feedback	
• Is the tone of the pitch effective?	**BIG YES** — **BIG NO**
• Are the visual and graphic design elements effective?	**BIG YES** — **BIG NO**
• Is the group cohesive in working on the proposal?	**BIG YES** — **BIG NO**

What Can I Offer? List any comments or suggestions here.