MY SUMMER IN SPACE

Grade level	Middle school, grades 6–8
Content areas covered	Science, with math and ELA extensions
Total time	Approximately 25 hours contact time
Experience snapshot	My Summer in Space is an NGSS- and CCSS-aligned project-based learning unit focused on the science of space. This project is designed to engage students through highly interactive and inquiry-driven activities. Activities are collaborative and adhere to the Design Thinking framework. As they work through this unit, students will address the driving question: "How can we design a product that will make us comfortable during our summer in space?" Ultimately, they will develop a prototype of their product and present it to an expert panel.
Next Generation Science Standards (NGSS)	NGSS MS-PS2-1 Motion and Stability: Forces and Interactions MS-PS4-3, MS-PS4-1 MS-ETS1-1: Engineering Design *NGSS Science and Engineering Practices:* Asking Questions and Defining Problems; Developing Models; Engaging in Argument from Evidence; Constructing Explanations and Designing Solutions *Disciplinary Core Ideas:* ETS1.A Defining and Delimiting Engineering Problems 5E Extension options: 07-PS1-6, 06-PS2-1, MS-LS1-5, MS-LS2-4, MS-PS4-3
Common Core Standards	Math extension options: CCSS.MATH.CONTENT.7.EE.B.3, CCSS.MATH.CONTENT.8.F.B.5 ELA extension options: http://www.corestandards.org/ELA-Literacy/W/8/1/, http://www.corestandards.org/ELA-Literacy/CCRA/W/, CCSS.ELA-LITERACY.SL.8.1, CCSS.ELA-LITERACY.SL.8.2, CCSS.ELA-LITERACY.SL.8.4

FACILITATOR MOVES

Phase I: Project Launch

1. To begin the project, show the "Okay Go Video," found here: https://www.youtube.com/watch?v=LWGJA9i18Co
    - As students view the video, ask them to write down their response to the following Visible Thinking Routine prompt: "What do you see? What do you think? What do you wonder?"
2. After showing the video, ask students to share their written responses aloud. Chart these on three "See, think, wonder" posters that can be revisited over the course of the project.
3. Provide students with Student Handout #1: Project Launch and Overview. Read it together as a class, asking students to use active reading strategies as they go.
4. Revisit the "See, think, wonder" charts and ask students to apply these same prompts to the project overview sheet they just read.
5. Lead students in a brainstorming activity to help them define the problem and develop a problem statement. Ask them to individually complete a "quick write" using the following prompts:
    - What are some things you would need to have to survive a month in space? What items would you need on a daily or weekly basis?
    - What would you need to stay engaged? Entertained? Clean? Safe? Productive?
    - What activities would you do? What would you want to learn about?
    - What questions do you have about surviving in space?
    - What would you want with you if you were spending summer in space?

STUDENT ACTIONS

Phase I: Project Launch

1. Students will view a video and complete a Visible Thinking Routine to help them analyze what they watched.
2. Students will collectively develop a list of observations and inquiries to be revisited over the course of the project.
3. Students will read the project launch sheet.
4. Students will further engage in inquiry related to their task and begin to consider space life.
5. Students will complete a "quick write" to develop a problem statement.

FACILITATOR MOVES

Phase I *(continued)*

6. If you are interested in thematically collaborating with a math teacher or looking to further integrate math content into this project, this video can be used to segue into a wonderful conversation about math: https://www.youtube.com/watch?v=pnTqZ68fI7Q. It directly relates to the following CCSS math standards:

   A. Solve real-life and mathematical problems using numerical and algebraic expressions and equations. CCSS.MATH.CONTENT.7.EE.B.3

      - Students could create mathematical expressions that help explain the patterning discussed in the video.

   B. Use functions to model relationships between quantities. CCSS.MATH.CONTENT.8.F.B.5

      - Students could pick a new song and create a storyboard of what the video would look like. They would need to match the storyboard panels to the time signatures of the parabolic pattern.

STUDENT ACTIONS

Phase I *(continued)*

6. Students can make math connections related to algebraic expressions and parabolic patterns, at the teacher's discretion.

FACILITATOR MOVES

Phase II: Problem Statements and Group Formation

7. After the brainstorming activity completed in step 5, ask students to write general/big ideas on post-it notes (one idea per note).

8. Have students move into groups of 4. Ask one student in each group to share one of their post-its aloud and place it either on a table or wall where the rest of the group can see. Ask each group member to repeat this process until all post-it notes have been read.
    - As students read and listen to the big ideas, they should begin to cluster similar ideas or questions together.
    - Teacher note: Be clear that this applies to the space station/other microgravity environments that could be in space, but not to all of space.
    - Ask students to look for patterns across the needs and questions, and to identify a theme for each cluster. Some examples you might share with students include groups like food, communication, entertainment, exercise, or scientific experimentation. These clusters will turn into the topics of student projects.

9. Students will now need guidance to self-select into project groups of three. To help them do this, provide students with a half sheet of paper on which to write down their top three choices from the topic clusters they identified in step 8. For each choice they should write a brief paragraph about why this topic interests them. Collect student responses and review them to help place students into project groups.

STUDENT ACTIONS

Phase II: Problem Statements and Group Formation

7. Students will brainstorm initial problems related to space life and write them on post-it notes.

8. Students will work in groups to identify themes across challenges related to space life.

9. Students will self-select into their project groups, based on interest.

FACILITATOR MOVES

Phase II *(continued)*

10. When students first meet their group, it is a PBL best practice to have them develop agreements or norms for working together. It is recommended that students now complete the optional student handout, "CraftED Group Game Plan."

11. The first task of the group will be to come up with a problem statement. Say, "Your group will now create a problem statement. This is the problem that your group will engineer a solution for." Provide students with Student Handout #2: Defining the Problem and review the directions prior to asking them to complete the process outlined in the handout.

    - If new to the engineering/design process, you can lead a class discussion about what engineers do and how they define problems. Consider the following prompts to help arrive at a solid problem statement:

        - "What is the need or desire that underlies the problem?"
        - "What are the criteria for a successful solution?"
        - "What are the possible trade-offs? "What evidence is necessary to determine which solution is best?"

STUDENT ACTIONS

Phase II *(continued)*

10. Student groups may work through CraftED's game plan to help them develop working agreements.

11. Students will complete Student Handout #2: Defining the Problem to develop their group problem statement.

FACILITATOR MOVES

Phase II *(continued)*

- While students are working in their groups, move around the room. Observe group behavior and help groups refine their problem statements. Possible problem statements include:
  - One challenge of spending a summer in space is being able to **use social media** (space need) and so we will need to solve the problem of **communicating and transferring data to Earth** (criteria).
  - One challenge of spending a summer in space is being able to **exercise** (space need) and so we will need to find a solution to **weightlessness** (criteria).
  - One challenge of spending a summer in space is being able to **eat** (space need) and so we will need to solve the problem of **getting fresh food** (criteria).

Once students have refined and settled on their problem statements, post them around the room.

STUDENT ACTIONS

FACILITATOR MOVES

Phase III: Empathy Work

Teacher note
See Lesson Investigation 1: Communication in Space as an optional class activity at this point. Students may not have chosen this topic, but this is an opportunity for the class to take a deeper look at an aspect of working and living in space and to cover NGSS **MS-PS4-3**.

12. For homework, ask students to bring in something that gives them comfort. Ask students to complete a journal quick write in response to the following prompt: "What are the characteristics of comfort?" Students can engage in a Think, Pair, Share protocol to process their journal responses. For an example of a Think, Pair, Share, visit: http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines/ThinkPairShare/ThinkPairShare_Routine.html.

13. Ask students to get into their project groups and generate a list of 8–10 questions that can help them understand challenges related to the user experience (in this case, a fellow teenager seeking to comfortably attend summer camp in space). You can provide students with the following sentence frames to help them get started.
    - "When you think of x, what does that mean?"
    - "What does doing x look like in a perfect world?"
    - "What are the essential elements of x for you?"

STUDENT ACTIONS

Phase III: Empathy Work

12. Students will complete a journal quick write to help them lay the foundation for the coming empathy exercise.

13. Project groups will generate a list of questions for interviewing an end user.

FACILITATOR MOVES

Phase III *(continued)*

14. Now, pair each group with another group for some empathy work. Note that each group will return to their empathy partner for the duration of the project. Tell students, "The point of this exercise is to understand the user/student experience in our design challenge." Using the questions generated by groups in step 13, students will interview another group of students to help simulate "end user" needs to give them further insight into the challenges associated with space life.

15. Ask groups to debrief the interviews to help them establish design criteria for their possible solutions. This may be challenging for students, so you can create some design criteria as a class. Some examples include:

    - Space need topic: Exercise
      - Criteria: Fun, involves soccer
      - Possible solution: Soccer ball attached to an elastic band
    - Space need topic: Entertainment
      - Criteria: Connected all the time and mobile
      - Possible solution: Space iPhone
    - Space need topic: Healthy eating
      - Criteria: Fresh food
      - Possible solution: Space garden

STUDENT ACTIONS

Phase III *(continued)*

14. Students will be assigned to an "empathy partner group" to help simulate an interview that will provide them with additional insight to the challenges associated with space life.

15. Students will create design criteria.

FACILITATOR MOVES

Phase IV: Individual Model Sketch 1

Teacher note
You may choose to complete Lesson Investigation 2: Laws of Motion. Students may not have chosen this topic, but this is an opportunity for the class to take a deeper look at an aspect of working and living in space and cover NGSS **06-PS2-1**.

16. Students will now individually create a hand-drawn, conceptual model of a solution that they think meets the needs of their empathy partner group. At this time, it is helpful to talk as a class about the purpose of developing and using models. Looking at the grade band in the NGSS appendix can be helpful for this conversation, in addition to showing students solid examples of models.

17. Provide students with Student Handout #3: Model Sketches, and ask them to complete Part I on their own. Note: It is important that their models are clear and well drawn and feature a design that could constitute a solution to the specific problem statement. Make sure students use pictures and labels to explain their model.

18. Have students move into their project groups to share their individual models. Ask groups to look for commonalities and new ideas across their individual ideas. Group members should work together to identify one idea from each individual model that they would like to apply to their group plans (see Student Handout #3: Model Sketches, Part II).

STUDENT ACTIONS

Phase IV: Individual Model Sketch 1

16. Students will discuss the importance of developing and using models in science.

17. Students will complete Student Handout #3, Part I to sketch a model on their own.

18. Students will complete Student Handout #3, Part II to sketch a model as a group.

FACILITATOR MOVES

Phase V: Developing Space Design Constraints

19. Students will begin class with a journal quick write in which they respond to the following prompt: "What are the unique design constraints of using something in space?"

20. Tell the students, "We are now going to listen to a podcast to help us better understand the constraints of designing for space. As we listen, I want you to journal about all the constraints that need to be considered when designing for space. You may also want to consider things that do not come up in the podcast." Then, play the following podcast for the class: https://www.wnycstudios.org/story/dark-side-earth. Be sure to provide context that the condition of weightlessness applies on the International Space Station, and other orbiting environments, but not everywhere in space.

    - Have students engage in a Think, Pair, Share protocol after they listen to the podcast. In the share-out, chart constraints generated by students. These design constraints should be kept as a list that is visible throughout the duration of the project. It may be helpful for students to revise this list throughout the project.
    - A sample list of space constraints includes:
        - Extreme heat when facing the sun
        - Extreme cold when not
        - Radiation
        - Weightlessness
        - Cramped space on the shuttle
        - Communication complications with Earth
        - Speed and velocity
        - Space debris
        - Human conditioning (disorientation)

STUDENT ACTIONS

Phase V: Developing Space Design Constraints

19. Students will complete a quick write to activate their prior knowledge.

20. Students will listen to a podcast to help them identify space design constraints.

FACILITATOR MOVES

Phase VI: Model Draft 2

21. Using Student Handout #3, Part III, ask the group to revise their first model. It can be helpful to tell students not to delete their ideas, but rather add to and change their model based on the design constraints.
    - Note: if you anticipate that any group dynamic issues will arise during this or any other collaborative stage of the project, consider using the teacher resource provided, "CraftED: Problem Solving Protocol."
22. After revising their model, students can give each other feedback on their second draft using the teacher resource provided, "CraftED: Collaborative Feedback."
    - Students can do this activity with their empathy partner group or with the class as a whole.
23. Students can then make a new sketch that accounts for peer feedback and design constraints. Note: This will be the design that students bring to prototype.

STUDENT ACTIONS

Phase VI: Model Draft 2

21. Students will revise the first draft of their model.
22. Students will give/receive feedback on their model drafts.
23. Students will apply feedback to their new draft of their model.

FACILITATOR MOVES

Phase VII: Collecting Evidence and Developing Claims

24. Before bringing their solution to prototype, students will need to evaluate their solution based on the criteria they developed as a class. Students will need to argue from evidence that their group solution will be able to withstand the rigors of space. To do this, prompt students to find two scientific readings that help them better understand their design solutions, prior to developing their prototype. For example, if students choose:

    a. Weightless, they may find something like this:
        - https://cnes.fr/en/what-weightlessness
        - https://www.space.com/6142-spider-success-weightless-webs-spun-space.html

    b. Radiation, they may find something like this:
        - https://www.nasa.gov/feature/space-radiation-won-t-stop-nasa-s-human-exploration

    c. Genetics/human conditioning, they may find something like this:
        - https://www.nasa.gov/feature/nasa-twins-study-investigators-to-release-integrated-paper-in-2018
        - NASA eClips™: Exercise in Space—Find out why exercise is so important to the astronauts who travel into space.
        - Train Like an Astronaut—Students train like an astronaut during this challenge.
        - Fit for Space—Get "the skinny" on how astronauts build a better body for space and what it means to you.
        - Do-It-Yourself Podcast: Fitness—Get information to help students write a podcast script about fitness.

STUDENT ACTIONS

Phase VII: Collecting Evidence and Developing Claims

24. As a group, students will research evidence for their group design solution.

FACILITATOR MOVES

Phase VII *(continued)*

- Running in Space! Video—Astronaut Karen Nyberg shows how astronauts run on the COLBERT treadmill in a weightless environment.
- Do-It-Yourself Podcast: Sports Demo

d. Space speed, they may find something like this:
- https://www.nasa.gov/centers/johnson/pdf/569954main_astronaut%20_FAQ.pdf

e. Nutrition, they may find something like this:
- https://www.nasa.gov/podcasts

If additional scaffolding is needed for the research process, use the teacher resource provided, "CraftED: Research Road Map."

25. After students have worked as a group to collect and read their research, they should now individually develop a claim from evidence that their solution (model) addresses the design challenge (problem).
    - You may choose to have students do this as a graded journal entry or collaborate with an ELA teacher to have them build out this writing assignment into an argumentative essay (http://www.corestandards.org/ELA-Literacy/W/8/1/, http://www.corestandards.org/ELA-Literacy/CCRA/W/).

STUDENT ACTIONS

Phase VII *(continued)*

25. Students will individually develop a claim supported by their group research.

FACILITATOR MOVES

Phase VIII: Prototype

Teacher note
You may now choose to complete Lesson Investigation 3: Space Garden. Students may not have chosen this topic, but this is an opportunity for the class to take a deeper look at an aspect of working and living in space and to cover NGSS **MS-LS1-5** and **MS-LS2-4**.

26. Before beginning to build group prototypes, collect materials for student use. At a minimum, students should have cardboard, tape, and scissors; however, consult this list of additional materials to enhance the prototypes: https://dschool-old.stanford.edu/groups/k12/wiki/56b69/Materials_List.html. Then, have students watch this video on how to create a cardboard prototype: https://www.youtube.com/watch?v=k_9Q-KDSb9o. Explain to students that they will create a prototype of their solution. They may use any of the supplies provided, but whatever they create must be a physical, workable prototype.

27. Prior to groups receiving access to materials, consult the teaching strategy provided, "CraftED: Team Huddle" to ensure that all members of the group have a clear purpose for this phase.

STUDENT ACTIONS

Phase VIII: Prototype

26. Students will watch a video on how to create a cardboard prototype.

27. Students may go through the process of a "team huddle" to help them assign tasks during the building phase of this project.

FACILITATOR MOVES

Phase IX: Empathy Round 2

Teacher note
You may now choose to complete Lesson Investigation 4: Heat Transfer. Students may not have chosen this topic, but this is an opportunity for the class to take a deeper look at an aspect of working and living in space and cover NGSS **06-PS1-4** and **07-PS1-6**.

28. After students have built and tested their prototype, bring them back to their empathy partner group for another round of feedback.
    - Students should watch their empathy group members engage with the prototype, and take careful scientific notes while they do so.

29. Have students return to their group to share out their observations and make any adjustments to the prototype.

STUDENT ACTIONS

Phase IX: Empathy Round 2

28. Students will observe their empathy partner group interact with their prototype.

29. Group members will work together to make revisions based on end-user feedback.

FACILITATOR MOVES

Phase X: Final Draft and Presentation

30. Provide supported work time for students to create their last draft of their space prototype.

31. Explain to students that they will present their final draft to a panel of experts. To prepare for this, you will need to assign students to work through the following:
    - Use a dynamic visual format of their choosing (a mini TED talk with Google Slides, interactive Prezi, mini documentary, etc.) to explain the task, show the process of their model, and present their final prototype.
    - Revisit the language of the presentation standards: CCSS.ELA-LITERACY.SL.8.4 and create a Y chart using the titles "looks like, sounds like, feels like," in the context of this project presentation, for the language of the standards.
    - Note: You will need to prepare expert panels, which can include local university science majors or professors, actual scientists, local space experts, and potential "end users" (teenagers not from this class who might attend such a space camp). You should also welcome parents and community members to serve as audiences for these panel presentations.

32. Students should present their findings to a formal panel in which they have 3–5 minutes to speak, followed by a 2–3 minute Q&A session by the panel.

STUDENT ACTIONS

Phase X: Final Draft and Presentation

30. Students will create their last draft of their space prototype.

31. Students will prepare to present their findings to a panel of experts.

32. Students will present to and answer questions from a panel of experts.