**Lesson Number 5: Engineering Design**

**Problem statement:** Students identify ideas for a space junk removal device using background knowledge (from previous unit lessons), provided material, budget, and time constraints.

**Learning objectives:**

Students will work collaboratively using design strategies and materials lists from lesson 4 to create a design plan of a space junk removal product and determine what materials are needed to carry out the building process within budget.

**Lesson standards (NGSS, CCSS, CTE):**

NGSS:

|  |  |
| --- | --- |
| 3-5-ETS1-2. | Generate and compare multiple possible solutions to a problem based on how well each is is likely to meet the criteria and constraints of the problem. |

ELA:

SL.5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

**Soft skills:**

* *Creativity*
* *Innovation*
* *Collaborating*

**Locally and/or personally relevant for students:**

All previous unit lessons have strictly involved students researching or discussing various various aspects of space junk. This will be personally relevant to each student in that they will be eager to move to the physical design phase of the Space Junk unit lesson plans after having investing all prior time in the research and discussions involving space junk.

**Connections to career and educational pathways:**

This unit lesson connects to careers in design engineering as well as in Project Management. While design engineering requires a strong background in STEM subjects, Project Management does not. As a result, this unit plan may garner interest from students that do not feel strong in STEM subjects but that possess strong organizational skills and team management skills. Refer to the Career Connections in the guidebook for real life examples of people that are involved in this field.

**Materials:**

Job description cards

[Engineering Design Notebook](https://docs.google.com/document/d/1kMMeTl-Pcx9m2RcLUDBP4B5Tl5u7AbYNn0l12WbI1bs/edit)

Space Junk Guidebook

Teacher Support Video: Participation Protocol to support participation quiz

Space Junk Game Navigator Worksheet

This lesson builds on the previous lesson where students were introduced to the materials they will be using to design their spacecraft. These materials might include:

aluminum foil, cardboard, space blanket, foam core board, construction paper, toilet paper tubes, pipe cleaners, paper clips, and straws.

**Lesson preparation:** Students will need the Engineering Design notebook either electronically on a google classroom, or printed out for each student. Teacher will need to again use the printed out job description cards for each group, and have all the classroom materials equivalents available for the student to explore.

**Time required:**

1 hour

**Grouping of students for instruction:**

Students will be in their teams of 4-5 students. In this lesson students will just begin to use new team member role cards to help them facilitate productive discussions.

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

|  |  |
| --- | --- |
| **Teacher** | **Student** |
| “Hello class, to start today, let’s review the work we did last session in our “Materials Specialist badge”. What observations, learning and connections can you share?”  (5 mins) | Students will report what they noticed, learned etc . from the last session. They will document their understanding on their own summary table. |
| “Now we will move on to today’s focus, “Engineering design”  Teacher will show clip explaining what engineering is:  What is Engineering  Bonus clip: What does a design engineer do?  NASA for Kids: Intro to Engineering:”  (5 mins) | Students will happily watch this quick video clip. |
| “Now that we have a framework from which to begin our engineering work for the day, I will share with you a new engineering journal we will be using to draw out our design ideas and much more.”  Hand out the engineering journal.  “Let’s do the first page together.”  Teacher uses a doc camera to go through the first page with students.  (5 mins) | Students will work on filling in page 1 of their engineering journal. Together work on identifying the problem, the design constraints (materials, 1 minute time limit, 12 inch footprint, etc.) These are also spelled out on the |
| “Next, I’d like to share with you these new job cards we’ll begin using today.”  Teacher will show the job cards and quickly describe each one to the class.  (2-4 mins) | Students will observe the teacher presenting the job cards. |
| “Now we’re going to work with our teams and brainstorm your ideas for your space junk removal product. Consider the constraints of the project during the design process. Make sure the materials you choose fit within the prescribed budget.”  (10 mins) | Student get together with their team to decide which items are most important for the design of their spacecraft. |
| “Now you have chosen materials and a design, option you engineering design journals to page 3 and draw pictures of your own designs.”  (5 mins) | Students open their design journals and begin drawing pictures of their ideas on page 3. Many of their ideas will be far fetched but all ideas are welcome. |
| Ask students to share out their favorite designs. | Students stand up and share out the designs they drew up and describe how they think their ship will work. |
| “OK Students now go back to your desk and draw a detailed picture of your spacecraft idea on page 4 of you engineering journal. Consider changes to your design from ideas shared out during the class discussion.”  (5 mins) |  |
| “Now please get out your guidebooks and answer 1-2 of the following questions for your exit ticket today :   1. What was the most difficult thing about staying under budget? 2. What would you build if money didn’t matter? 3. What parts of your design were most difficult to draw in 2D? 4. What features are you most excited about with your design?”   (5 mins) | Students will answer the reflective guidebook questions to demonstrate learning for their Engineering Design badge. |

**Accommodations:** Allow access to Smartdraw or another computer drawing program for students to use in place of the paper and pencil version. The engineering and design notebook could also be electronically accessed through Google Classroom.

**Extensions:** Computer aided design of the space junk removing craft or device.

**Assessment:**

Formative Assessment in the Lessons: This is an appropriate lesson to conduct a participation quiz.

Formative student data is also available in the students’ summary table, and in their guidebooks with their reflection questions.

**References/Resources:**

Teacher Support Video: [Participation Protocol](https://www.teachingchannel.org/videos/participation-protocol-ousd) to support participation quiz

**For Class:**

* [What Does an Engineer Do](https://www.youtube.com/watch?v=a2zYEuIcLMA)?

**For Guidebook**

* <https://www.engineergirl.org/>
* ***Youtube:*** [NASA - NASA for Kids: Intro to Engineering](https://www.youtube.com/watch?v=wE-z_TJyziI)
* ***Youtube:*** [Crash Course Kids - What is an engineer?](https://www.youtube.com/watch?v=owHF9iLyxic)
* <http://tryengineering.org/home>