**Lesson 7: Optimizer**

**Problem statement:** In this unit lesson, students will test and identify ways to improve their space junk removal products.

**Learning objectives:** Students will look at the success and failures of their model and make informed decisions on how to optimize the model to be more efficient.

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

**NGSS:**

3-5-ETS1-2 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

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

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

**CCSS:**

6.RP.A.3 Ratios and Proportional Relationships: Understand ratio concepts and use ratio reasoning to solve problems.

6.SP.B.5 Statistics and Probability: Summarize and describe distributions. Giving quantitative measures of center

**Computer Science:**

1B-D-5-13 Answer a question by using a computer to (e.g., sort, total and/or average, chart,  
graph) and analyze data that has been collected by the class or student.

**Soft skills:**

* *Critical Thinking*
* *Creativity*
* *Collaboration*

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

This lesson is a little more challenging than the previous lesson in that students must try and identify ways to improve or enhance their space junk removal products. This requires students to "think out of the box" in order to improve their designs, but also stay within the defined constraints of the challenge. In terms of how this is personally relevant to students, students utilize various forms of technology in their lives that represent some form of optimization (smaller cellular devices, faster computing speeds, etc) overtime. Students will need to display similar ingenuity towards improving their products.

**Connections to career and educational pathways:**

This unit lesson provides a snapshot into both a career in industrial engineering, as well one in process engineering. These careers involve identifying ways to optimize a system or process, and to eliminate any waste that may exist. Utilizing lean methodologies are ideal in taking a systems approach to finding a solution to a given problem. Refer to the Career Connections section of the guidebook for real life examples of people in these fields.

**Materials:**

Summary Table from all previous lessons

Space Cadet Academy Guidebook from previous lessons

Space Junk Game Navigator Worksheet from previous lesson

Engineering Journal

Presentation Feedback Form

**Lesson preparation:**

Students will need their spacecraft built in lessons 5 and 6 to make design changes.

**Time required:** Approximately 1 hour

**Grouping of students for instruction:**

Students will continue working in the collaborative groups they were in during the design and build stage.

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

**Understanding the Problem**

|  |  |
| --- | --- |
| **Teacher** | **Student** |
| “Today we are going to take a look at our models and OPTIMIZE them! We’re going to watch a quick video (Elon Musk On What Went Wrong With SpaceX's Falcon Heavy Flight) to think about how Space X deals with its mistakes.  (5 mins.) |  |
| Let’s go back and think. Who can tell me something that worked well with their design?  (5-10 mins.) | Allow for student responses. |
| In your engineering design book, let’s go to page 6. Take some time in your groups to talk about what worked well. You can also talk about what improvements you would like to make to improve your design. This is the chart for the top of question 7. (Give 10 minutes or so, and monitor discussions.) | Allow student groups to work together to collect their thoughts. |
| Who has a design aspect they are excited to share about how they are going to improve? | Students can share as needed. |
| Now let’s look at the rest of page 6. If you know what improvements need to be made, how are you going to make that happen? What parts of your current design already work and you want to make sure and keep? As you move on to page 7, you have some space to draw what you would like to change. (up to 10 mins. Allow some independent, quiet think time.) | Students look back through their journals. They have time to think and plan. |
| Now you can work to share your ideas with your group. Make sure you keep what is effective, and plan out how you can make the improvements you want that were listed on page 6. Once you can show me your plan for improvement, your group can get out your supplies and get started. | Students work to share their ideas. They must show their improvement design before they are allowed to get their supplies to work. |
| Monitor as groups transition from planning to implementing their change. | Students take their plans and put them into practice. They can test their new design once their improvements have been made. |
| Remind groups to complete page 8 as they are testing their improvements.  (10-20 mins.) | Students complete page 8 about data (graph, drawings, and written observations) |
| As they wrap up optimizing their product begin to provide teams with Presentation Feedback Form they will be using for presentations. This will help them begin to prepare for the next lesson. | When done optimizing students will use this form to start to plan their presentations. |
| Let’s put all of our materials away. (Building supplies only, keep engineering book)  (5 mins) | Students clean up supplies. |
| “Now please get out your guidebooks and answer 1-2 of the following questions for your exit ticket today:   1. What was most useful about optimizing your design? 2. How did your optimized design work better than your original design? If not, how was it less effective? 3. What was challenging about optimizing your original design? 4. Describe any new special features you are excited to share with the class.   (5 mins) | Students will answer the reflective guidebook questions to demonstrate learning for their Optimizer badge. |

**Accommodations:** Students that need additional support in helping their teammates may need more direct instruction, to-do lists, or directions for how to make improvements broken down into smaller steps.

Highly capable students might be encouraged to research robotics features in the space industry and attempt to engineer features in their products to mimic these.

**Extensions:**

Students could video their groups presentation, and or create an ad campaign sort of plan for their presentation.

Groups can create a scratch version of their game play plan for additional coding experience.

**Assessment:**

Formative Assessment in the Lessons: Students will complete responses to their Space Cadet Guidebook questions.

This would also be an effective lesson in which to use a participation quiz if needed.

As students engage in optimizing, you can formatively assess using anecdotal notes or observations on which students are engaged in this portion of the engineering process.

**References/Resources:**

**For Class:**

# ***Youtube***: [Elon Musk On What Went Wrong With SpaceX's Falcon Heavy Flight](https://www.youtube.com/watch?v=NwCsuAeamXE)

**For Guidebook:**

* <https://www.space.com/14379-apollo1-fire-space-capsule-safety-improvements.html>
* <https://www.sciencebuddies.org/science-fair-projects/engineering-design-process/engineering-design-process-steps>