**Lesson 8: Title:** Engineering a FOD system - Test, Evaluate, Improve/Redesign

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| **Lesson** | **Title & Short Description:** | **Learning Outcome:** |
| **#8 -** | Engineering a FOD system ~ Test & Evaluate & Improve/Redesign stage  Students will share their design with their classmates, collect data and evaluate the effectiveness of their system. They will then redesign their prototype. | Students will test and evaluate their ‘system’ to see if it meets the criteria. They will redesign and improve their initial system. |

**Problem statement: *How can we improve our production process so that we have less debris (foreign object debris or FOD) left on the SPACE during the build stage and can deliver a clean, safe SPACE? What turns an object into a FOD?***

**Learning objectives:** I can test and evaluate my prototype organizational system for our classroom that will help prevent F.O.D. (foreign object debris) from occurring in my classroom for a week.

**Standards:** Next Generation Science Standards (NGSS), Common Core Standards (CCSS)

**NGSS:**

**5-PS1-3:** Make observations and measurements to identify materials based on their properties.

**3-5-ETS1-1:**

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 our controlled and failure points are considered to identify aspects of a model or prototype that can be improved

**CCSS**

CCSS.Math.5.NBT.B.7

Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

[ELA-LITERACY.SL.5.1](http://www.corestandards.org/ELA-Literacy/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.

[CCSS.ELA-LITERACY.SL.5.1.A](http://www.corestandards.org/ELA-Literacy/SL/5/1/a/)

Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

[CCSS.ELA-LITERACY.SL.5.1.A](http://www.corestandards.org/ELA-Literacy/SL/5/1/a/)

Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

[CCSS.ELA-LITERACY.SL.5.1.C](http://www.corestandards.org/ELA-Literacy/SL/5/1/c/)

Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

[CCSS.ELA-LITERACY.SL.5.1.C](http://www.corestandards.org/ELA-Literacy/SL/5/1/c/)

Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

**Soft Skills:**

Listening, Critical Thinking, Collaboration, Communication (written and oral), Creativity & Innovation

**Materials:**

* Copies of Student Planning Sheet
* Copies of Lesson 8\_Organizational System Rubric
* Cardboard boxes of all shapes and sizes(Hint: Ask your school custodian to start saving boxes for you like copy paper boxes at least a week ahead of time. You will want at least 12 boxes of different sizes if you have groups of 3-4 students.)
* Masking tape and/or duct tape
* Glue
* Cardstock or poster board - any heavy duty paper will work
* Scissors - for students to cut
* Colored Markers
* Optional but very helpful: Computer or other device if students want to create and print a picture of where certain items go in their organizational system.
* Optional but very handy: Yarn, popsicle sticks, aluminum foil, straws - best to have these in a clear container if you have one.

**Lesson preparation:** Finish lesson 7

**Time required:** 1 hour to initially test; 1 week as per criteria to test effectiveness.

**Grouping of students for instruction:**

Students will be placed in groups of 3-4 people. They will be using the Organizational System Rubric to evaluate their first prototype. Then, the groups will use the last page of the planning sheet to redesign their organizational system. Groups can assign roles for each person such as recorder, supply manager, time keeper, project manager, and so on.

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

The students are in the evaluation phase of the PBL unit. They are now testing their own organizational system now that they have learned the importance of being organized. As part of this task, they will also learn about ‘constraints’ of time, supplies, and money, which relate to the design process in the real-world.

**Understanding the Problem**

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| **Teacher** | **Student** |
| 1. The teacher will ask the students to get out their “Student Planning Sheets’ packet from the last lesson. She will review the Engineering Design task criteria for a ‘successful’ product with the students. | 1. Students will get out their Student Planning Sheet. They will ask clarifying questions about the project. |
| 1. The teacher will hand-out the Lesson 8\_Organizational System Rubric to each group. She/he will explain that they will be evaluating their own system as well as another group's system. Teacher will assign the team that each group will be evaluating in addition to their own.This allows for more accountability and feedback.   **(Important note**: Teachers should adjust the rubric as needed for their classroom. You may want to adjust the criteria that allows a system to ‘pass’ or ‘fail’.) | 1. Students will read through the Lesson 8\_Organizational System Rubric with the teacher and ask clarifying questions. |
| 1. The teacher will have the groups check the area where their organizational system is placed daily during the test week. The students will record their results on the Lesson 8\_Organizational System Data Sheet. | 3. Students will use the rubric as a guide to collect data on their Lesson 8\_Organizational System Data Sheet. At the end of the week, they will use the rubric to evaluate whether their system meets the criteria. |
| 1. The teacher will have the students meet again after their first one week trial to ‘redesign’ their initial prototype and make improvements based off of the data the teams collected and their rubric ‘grade’. The teacher will direct the students to the last two pages of the Student Planning Sheet (page 6 & 7) to reevaluate, plan, and draw out their new design. | 4. In teams, the students will analyze data from their data sheet and rubric that they filled-out as well as any additional completed rubrics from their classmates. They will use this feedback to redesign and improve on their original prototype. Students will evaluate and plan their new design on the last two pages of the Student Planning Sheet (page 6 & 7). They will decide what additional materials they may need to make their second design. |
| 1. The teacher will provide additional supplies to the teams to allow them to create their redesigned Organizational System. (See Lesson 7 for additional information. Teachers can choose to set spending limits again, or just allow each group to be able to ask for ‘x’ amount of items.) | 5. In teams, the students will create their redesigned Organizational System. They will collaborate together to make any changes. (At the end of the engineering session, they will use the Lesson 7 - Excelling as Engineers rubric to evaluate how they did on the lesson.) |
| 1. The teacher will have the students test their final design for one more week using the Lesson 8\_Organizational System Data sheet and Lesson 8\_Organizational System Rubric as a guide. | 6. Students will use the Lesson 8\_Organizational System Data sheet and Lesson 8\_Organizational System Rubric as a guide to evaluate whether their second system meets the criteria |

**Accommodations:**

Students with special needs or accommodations (IEPs or 504s) can have some extra one-on-one time with the teacher(s) to help clarify the project's criteria and constraints and provide additional support as needed. Students can also use a computer to help create their design versus doing their design by hand on paper. Finally, a student might be given sentence starters or examples of other similar design solutions as a starting point for designing their system.

**Extensions:** Analyze another, additional team’s data. Master guide of data postings so teams can see each other’s work?

**Assessment:**

* Formative based on teamwork rubric - (Lesson 7 - Excelling as Engineers!)
* Lesson 8\_Organizational System Rubric
* Lesson 8\_Organizational System Data sheet
* Optional: Students can write a reflection in their science journal about

**References/Resources:**