**Lesson 7: Title:** Engineering a FOD system -Build/Create

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| **Lesson** | **Title & Short Description:** | **Learning Outcome:** |
| #7 - | Engineering a FOD system ~ Build/Create stage  Students will create a prototype of their organizational system with their group. They will test it for a few days to see if it works | Students will create a prototype of their organizational system with their group. They will test it for a few days to see if it works |

**Problem statement: *How can we improve our production process so that we have less debris (foreign object debris or FOD) left on the target SPACE during the implementation stage (when we are trying out this process) and can deliver a clean, safe SPACE?***

**Learning objectives:** I can collaborate with my group to build and create our 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
* 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 6

**Time required:** 1-2 hours

**Grouping of students for instruction:**

Students will be placed in groups of 3-4 people. They will be using a planning sheet to design 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 ‘explore’ phase of the PBL unit. They are now designing their own organizational system now that they have learned the importance of being organized. As part of this task, they will also continue to focus on the criteria set forth in the design instructions as well as the ‘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 with the students, especially the criteria for a ‘successful’ product and the constraints. | 1. Students will get out their Student Planning Sheet. They will ask clarifying questions about the project. |
| 1. The teacher will ask the project managers in each group to come get the group's original set of supplies. (Remember, each group should get a box (size of their choosing), 1 meter of masking tape, markers, scissors, and 4 sheets of cardstock.) | 1. Students will send their project managers to get the group's original set of supplies. They will arrange these supplies in their group space. |
| 1. The teacher will ask the materials managers in each group (one at a time) to come ‘purchase’ their supplies for their group. Remind the students to bring their order sheet (page 5 of their planning packet) with them. | 1. Students will send their materials managers to collect their additional supplies. They will arrange these additional supplies in their group space. |
| 1. The teacher will remind the students that they have 1 hour to create their first prototype. She will also remind them to make sure everyone in the group has a role in helping to create the organizational system. (Students should look through their design and create a step-by-step process. Then they should assign different people in their group to each step.) | 1. Students will start creating their first prototype. They will assign everyone in the group a role in helping to create the organizational system. To do this, the students create a step-by-step process for their design process. Then they will assign different people in their group to each step. |
| 1. The teacher will monitor the groups as they create their organizational systems. She will offer tips and encouragement without giving any advice as far as the design of the project is concerned. She will encourage the groups to problem-solve any solutions for when they get ‘stuck’ or run out of supplies. | 1. Students will work together in a collaborative way to create their prototype. They will ask clarifying questions to their teacher and to each other about their project. They will communicate their concerns and offer advice to one another in a supportive way. They will problem-solve any solutions for when they get ‘stuck’ or run out of supplies. |
| 1. Optional: The teacher can announce a new ‘investor’ has taken interest in their projects and has just given each group another \_\_\_\_ amount of money. This is useful if she notices that several groups are already out of supplies and will not be successful without additional materials. | 1. Students will work together to create an additional list of supplies that they might need using this new amount of money. (Note: if they are doing well with their current supplies, they can always purchase more items to make their organizational system more interesting and appealing. |
| 1. After an hour, the teacher will give the groups a five-minute warning that they need to ‘wrap-up’ their creations and put their organizational systems in the area of the room where they will be tested. She will also instruct the teams to clean-up their workspaces. | 1. Students will ‘wrap-up’ their creations and put their organizational systems in the area of the room where they will be tested. They will also to clean-up their workspaces. Students should carefully store any left-over supplies for later in case they may want to use them to improve their designs. |
| 1. The teacher will give each student a Lesson 7\_Excelling as Engineeers\_Prototype Rubric to fill-out. This will help the teacher assess how well the groups worked together and if she needs to meet with a particular group to coach them on the importance of collaboration and how to work through their differences. | 8. Each student will thoughtfully fill-out a Lesson 7\_Excelling as Engineeers\_Prototype Rubric. They will reflect on how well their group worked together to create their prototype and what soft skills (the 4Cs) they may need to improve on next time. |

**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 theri 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:** Students can create an organizational system for keeping more than one area of their classroom organized, or they can also design and create an organizational system for keeping an area at home clean, organized, and F.O.D.-free for a week.

Another extension idea: Encourage students to find a way to incorporate biomimicry – such as a bee-hive - into their design ideas, or introduce unexpected or unpredicted elements that could cause additional damage to an area (e.g. earthquake which tumbled everything down or Covid Protocols negated parts of plan).

**Assessment:**

* Lesson 7\_Excelling as Engineeers\_Prototype Rubric

**References/Resources:**

* Authors - Kathleen Wong, Caroline Kelly, Sue Gabica