**Lesson 6: Title:** Engineering a FOD system - Imagine/Plan

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| **Lesson** | **Title & Short Description:** | **Learning Outcome:** |
| #6 | Engineering a FOD system ~ Imagine/Plan Stage  Students are introduced to the Engineering Project:  Students will be asked to design a system to organize and store supplies in an area of their classroom. | Students are asked to design an organizational system for keeping the items in an area of their classroom organized. |

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

**Learning objectives:**.I can collaborate with my group to create an innovative, attractive organizational system for your 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 the 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:** 30-40 minutes

**Time required:** 60-90 minutes (Time for groups to draw their plans and gather materials needed. May also have time to start building their first prototype.)

**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 learn about ‘constraints’ of time, supplies, andmoney, which relate to the design process in the real-world.

**Important note!**

It is important that the teacher places some constraints on the Engineering Project. In the real-world, engineers do not get an unlimited amount of supplies, time, or money to complete a project. In the classroom, if students are allowed to take whatever supplies they want rather than thoughtfully thinking through what supplies they actually need, they will most likely waste supplies and the end product will not be as carefully designed and created. We have witnessed many projects that end up being mostly completed with too much masking tape or duct tape. Therefore, it is highly recommended that the teacher limits the supplies used at first as the students explore and create. An anonymous investor can always come along and ‘gift’ more supplies to the teams that are working well together or that have an innovative design. 😉

**Understanding the Problem**

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| **Teacher** | **Student** |
| 1. The teacher will introduce the Engineering Design task to the students. She will hand out the ‘Student Planning Sheets’ to EACH student. | 1. Students will read along with the teacher as she introduces the engineering task. They will take notes as needed on their Student Planning Sheet. |
| 1. The teacher will read through page 1 of the Engineering task. The teacher will carefully explain the ‘criteria’ (What are the students creating and how we will know if we are successful?) and the ‘constraints’ (What are the limiting factors such as time, supplies or resources, and money?) | 1. Students will read along with the teacher as she introduces the engineering task. They will take notes as needed on their Student Planning Sheet. They will ask clarifying questions about the project. |
| 1. The teacher will read through page 2 of the Engineering Design Project - the ‘Ask’ and ‘Imagine’. She will give the students 10 minutes to ask questions and fill-out the “Gather information and generate ideas” section of this stage of the design project. She will answer any clarifying questions for the students about the ‘Limiting Factors and Criteria”.   Note: The teacher may want to decide ahead of time a list of areas and/or items in the classroom that could use organizing. This could be sections of the class library, class games, a Makerspace area, science supplies, engineering supplies, art supplies, etc. | 1. Students will fill-out the “Gather information and generate ideas” section of their paper. They will ask any clarifying questions about the ‘Limiting Factors and Criteria”. |
| 1. The teacher will assign students to their groups now. The students will meet to share their initial thoughts and ideas. The teacher will give the students 10-15 minutes to share their initial ideas. | 1. The students will meet with their teammates to share their initial thoughts and ideas. They will share their ideas for what area or supplies in the classroom they would like to try to organize using a new system. |
| 1. The teacher will ask the students to go back to their own seats for 15-20 minutes to sketch two different designs of possible organization systems. She will remind them to be sure to include ALL of the supplies that you will need and add labels! Monitor the students to make sure each student has at least one design written down before meeting back with their group.   Note: The teacher should give the students time to do this initial planning stage individually. Otherwise, some students will just take charge of the project and everyone’s ideas may not be included. This is similar to a ‘think-pair-share’ strategy. If you want everyone’s ideas to be acknowledged, the students need time to work individually first. | 1. The students will individually sketch two different designs of possible organization systems. They will be sure to include ALL of the supplies that they will need and add labels! |
| 1. The teacher will ask the students to gather back with their group to share their individual ideas. Have the students go through the ‘advantages/disadvantages’ section on page 4 of the design packet. After 15 minutes of sharing, have them choose a project for their initial prototype. | 1. The students will meet with their group members to share their individual ideas. Each student should take turns sharing their design ideas. The students should then go through the ‘advantages/disadvantages’ section on page 4 of the design packet. After 15 minutes of sharing, they should choose a project for their initial prototype. |
| 1. Finally, the teacher will ask the students to complete page 5 of the ‘Lesson 6- Student Planning Sheets’. The teacher will go over the initial supplies that each group will have to start their project. The groups will be asked to create a budget for their final design project. They then should sketch out this prototype design, create their budget on page 5, and submit it to the teacher for ‘approval’. (The teacher will ‘approve’ the design if all the parts of the planning sheet are completed. | 1. The students will create a budget for their final design project. They will assign roles to each person in their group: recorder, supply manager, time keeper, project manager, and so on. The students will then sketch out this prototype design, create their budget on page 5, and submit it to the teacher for ‘approval’. (They will start building their prototype during the next lesson!) |

**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 writing 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.

**Assessment:**  The organizational system ‘fails’ if more than 2 students have to ask how to use it; if the system doesn’t hold-up to regular use after one week, or if your consumers (classmates) continue to misplace the items that are meant to go in the system.

Students will be given a rubric to grade themselves and others based on the criteria laid out in the project overview sheet.

**References/Resources:**

* Lesson 6- Student Planning Sheet