**Lesson Number 6 - Master Builder**

**Problem statement:** Students will build off ideas, concepts and discussions about ideas for collecting space junk. Primary focus will be spent on constructing a space junk removal device.

**Learning objectives:** Students will take the ideas from the engineering design and work within the constraints of design, function, and budget to build a preliminary model of a spacecraft to collect space junk.

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

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.

**Soft skills:**

* *Collaboration* with other fellow builders
* *Critical Thinking* in following standard operations, taking measurements, and producing no defects in constructed item

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

This Unit Lesson Plan delves into a career that doesn’t require the traditional educational path of going to college. In addition, this type of career enables an individual to pursue a career in a STEM industry (ex: aerospace) without being strong in STEM subjects such as math or science. Many companies also provide opportunities for employees to pursue higher education opportunities if a worker does want to increase their knowledge in a certain field usually after 1-2 years of employment. This unit lesson should hopefully attract interest from students that do not feel strong in a certain STEM subject, or who are more interested in the physical construction of something.

**Connections to career and educational pathways:**

This unit lesson plan will provide a glimpse of what a general construction worker does; whether it be an airplane mechanic or a construction worker or anything in between, students will learn the basic elements of building something using various materials. Refer to the Career Connections section of the guidebook for real life examples of people that are in this field.

**Materials:**

* The building materials from the previous lesson will be needed for the class “store”. Heavy duty aluminum foil, cardboard, aluminum foil, space blanket (mylar), foam core board, cardstock, felt, pipe cleaners, popsicle sticks, paper clips, straws, rubber bands, wire, TP rolls, magnets, string, mesh/netting, scissors, glue, rulers, masking tape, hot glue, duct tape, pencils, etc.
* Bins for supplies, with a marking spot for a team name, like a piece of painters tape or blank sticker.
* SJRS (Space Junk Removal Systems) Shopping List from lesson 5
* Job Descriptions cards
* Space Junk Game Navigator Worksheet

**Lesson preparation:**

Set up a “shopping” area for students to get their supplies from. Or make bins/bags of supplies for each table group to “shop” from.

**Time required:**

**2+ hours**

**Grouping of students for instruction:**

Groups are established in lesson 1 and can carry through or be adjusted as needed.

Small groups, use job cards to identify their responsibilities.

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

|  |  |
| --- | --- |
| **Teacher** | **Student** |
| Before class the teacher will need to set up a “Store” for the space junk removal systems (SJRS) materials.  Teacher will also provide each team with $400 in play money, and a bin to put their materials/product in. |  |
| “OK class, today we are going to build our space junk removal spacecrafts! So, let’s very quickly reflect on what we covered last time in our “Engineering Design” badge on our summary table so we can get right to work!”  Teacher will work with the class quicky to identify observations, learning, and connections they made to the space junk problem in the previous design lesson.  (5 mins) | Students will contribute to the discussion on what was observed, learned and connected to from the previous lesson on design. They should copy these notes on their own summary table. |
| Teacher may show this optional video to also refocus the class on the challenge at hand: <https://www.youtube.com/watch?v=7CEH9V9psKY>  This video depicts potential experiments for space junk removal.  (3-4 mins) | Students will watch the intro video of the day! |
| “What are some things to consider as you review  the designs of you spacecraft?”  Make a T-Chart with topic headings;  **Design | Function**.  **Design** designates the design of the craft and the needs associated like heat resistance and structures to address gravity and landing for example.  **Function** designates tools to collect, store and deliver space junk.  (5-10 mins) | Students will bring out their engineering notebooks and open to their design page.  Students will engage in a conversation about the important design parts of their favorite craft. |
| “Next we will meet with our groups to determine a final design for your spacecraft. Make sure you use your Group Consensus Protocols when making a decision. You may consider small changes to your design as long as the budget constraints are addressed. You will have 10 minutes to decide on which design you will choose for your group project. Remember, you all want the same end result so think about the purpose of your spacecraft.”  Release students to their groups, monitor conversations to make sure they are adhering to the group consensus protocols.  During this time, and later during group building the teacher can conduct a “participation quiz” to ensure productive group work.  (10 mins) | Students gather with their group to review designs. Students will be excited to choose the design of their spacecraft. |
| “Now that you have determined your final design, it is time to begin shopping using your $400 (amount can be adjusted as needed) budget.  The “recorder” for your team will use the Shopping List to record what materials you need to purchase.  The “Materials Manager” will then use this list, and your money to do the shopping. This helps keep the store from overcrowding!”  (5-10 mins) | The recorder will record the items needed based on the tea design, with support from teammates.  The materials manager will do the shopping. |
| “Now that you have your materials, each person on the team needs to be supportive in the building process. I’ll be looking for teams that listen to their “moderator” to help them successfully share in the workload of building.  Don’t forget to have your “investigator” ask questions, look at the game field, and help to keep the group responsible for adjusting the model as needed. Also, be sure to try and use your design plans and the SJRS Design Challenge doc with listed constraints.  (10-20 mins) | Students will be building their model, being sure that it works for the game board, everyone is taking a turn in building, and using their time wisely.  Students can work ahead on their summary table when they are not actively building. |
| Building it likely to take multiple sessions, or one long session. If using multiple days, teacher will say,  “Our time is up for today, please gather materials, leftover money, etc and put it in your team bin. Add your team name to the marking spot on the bin.” | Students will gather up supplies and store them until the next build session. |
| At the second meeting for a build session, or second half of a session, begin by completing the summary table for the “Master builder badge”. Students will help report on their observations, learning, and connections made. | Students fill out the “Master Builder” page on their summary table. |
| Students will gather up their bin and resume working on their construction project. They will continue to make sure to share in the workload. | Students will be constructing their SJRS product. |
| Teacher conducts a formative observation during this time to note how students are working on this engineering process. It would make sense to take notes on participation. A more formal participation quiz could also be used at this time. | If using a participation survey students will be informed of their participation scores a few times during the lesson, and then will adjust their participation levels accordingly. |
| With about 10 minutes of the session remaining, have “reporters” share out about how the building is going for their team so far. | Reporters will report to the class about 1 part of the build that is going well and 1 frustration. |
| Students will gather materials and store their products away until the next session. | Students clean up materials. |
| “Now please get out your guidebooks and answer 1-2 of the following questions for your exit ticket today:   1. Where you able to create the design you visualized? 2. What parts of your design did or didn’t work? 3. What changes did you make to your original design? 4. What features are you now proud of?   (5 mins) | Students will answer the reflective guidebook questions to demonstrate learning for their Master Builder badge. |

**Accommodations:**

Students will be working in small groups and should have support within those groups. If a job needs to be shared for example, that might help ease anxiety or frustrations.

**Extensions:** Students could create computer aided models if the applications and technology is available. Even if a parent had access to computer aided modeling their student could give the class a demonstration on how computer aided modeling differs from hands on model building. Programs such as sketch up or on shape could be utilized. These and other additional resources are listed in the guidebook.

**Assessment:**

Formative Assessment in the Lessons

~ Students will participate in a “Participation quiz”

~ Formative observation notes should be taken during work times to note how students are participating in the engineering process.

~ At this point students should be confident in their ability to document their understanding on their summary tables, the teacher will want to note who is challenged in participating in these discussions and support those students.

~ Students will also be documenting their reflective question answers in their guidebooks for this lesson and this is a piece of today’s formative assessment as well.

**References/Resources:**

**For Class:**

# [Space Debris removal mission animation](https://www.youtube.com/watch?v=7CEH9V9psKY)

**For Guidebook**

* <https://www.onshape.com/>
* <https://www.lego.com/en-us/ldd>
* <https://www.sketchup.com/>
* <https://archkidecture.org/>