Engineer a Space Capsule

In this activity, youth engineer space capsule that can land in water and protect two astronauts inside. Using a simple engineering design process, they imagine multiple solutions to their challenge, establish criteria for their design, and use readily available materials to design and test it.

Timing: 90 minutes, divided into 12 distinct steps.
This lesson can easily be broken into multiple sessions.

Materials:

Assorted household supplies (materials can vary)
Engineering Journal

Step 1: What is Engineering? (5 min.)

Engineers solve problems by designing objects and processes.

- *What kinds of things do you think engineers have designed that help astronauts survive and do their work in space? (space suits, telescopes, rover vehicles, rockets)*

Engineers often use an engineering design process (EDP) like the one shown in your Engineering Journal.

- *Why do you think engineers use this tool?*

Step 2: Learn about space capsules (5 min.)

Space capsules are used to return astronauts to Earth after they have completed their space missions. They land in the ocean where a boat is waiting to pick up the astronauts and their equipment. Look at the pictures of various space capsules in your Engineering Journal.

- *Why do you think space capsules are designed to land in water?*
- *What do you notice about the shape of the various space capsules?*
- *Why do you think space capsules have parachutes?*
- *How do you think astronauts breathe inside a watertight capsule?*

Watch this short video of a SpaceX Capsule landing in the Gulf of Mexico in August of 2020 to see what a space capsule splashdown looks like.
https://www.youtube.com/watch?v=4cy68OoNHF0

Step 3: Decide on criteria (5 min.)

Your engineering challenge is to design a model space capsule that can survive splashdown, float on the water after landing, and protect the astronauts.

To solve any problem, engineers need to know what the end product needs to do. Look at the *Design Criteria and Testing Results* table in your Engineering Journal. It shows that your space capsule must:

- Survive splashdown into water when dropped from 5 feet
- Float in water for 1 minute after landing
- Keep the astronauts dry

In addition, you must choose one other feature for your space capsule. Choose one criterion from the list below (or make up your own) and add it to the criteria column in your Engineering Journal.

- Includes a parachute to slow down drop speed parachute
- Keeps itself right side up when floating in water
- Can carry up to 5 astronauts
- Is compact (under 3 inches)
- Opens easily to get astronauts out
- Is reusable
- Other: A criteria you identify: My capsule will: _____.

Step 4: Prepare for testing (5 min.)

Engineers use tests to determine whether their designs meet the goals they set. Thinking about these tests early in the engineering process helps engineers brainstorm solutions that will be successful.

The second column of the *Design Criteria and Testing Results* table shows how you will test your instrument to make sure it survives splashdown, floats in water, and is waterproof.

- *How you might test the criterion you selected? Add your ideas to the table in the Engineering Journal.*

Step 5: Think about materials (5 min.)

Engineers carefully choose materials that will help them design a product that meets all the requirements. Based on your design criteria:

- *What materials might work well to make the body of the capsule?*
- *What small items can you put inside the capsule to represent two astronauts? (for example: coins, paper clips, erasers, action figures, or figures drawn on paper)*

Discuss your ideas with a partner, group, or instructor.

- *Why do you think the materials you chose will work well?*
- *What properties do they have?*
- *What other materials could you use to create this design?*

Step 6: Collect your materials (10 min.)

Based on the properties you described, gather materials that could be used to make your space capsule. If you can't find the exact material, look for one with similar properties. Tell a partner, group, or instructor about the materials you found.
Be sure to:

- Make sure it's OK to use them! (Ask permission if you need to.)
- Gather any tools you might need to build the space capsule (for example, scissors, tape, glue, stapler, etc.)

Step 7: Brainstorm ideas (10 min.)

Engineers come up with creative ways to solve problems by considering many different ideas before deciding what to make. They talk with their teammates to get even more ideas. All designs are strengthened by feedback from others.

Using your Engineering Journal, sketch out at least 2 possible designs for your space capsule. Sketch your space capsule and show the astronauts nestled inside. Think creatively!

Share both of your design ideas with a partner or the group. Make tweaks to your designs based on others' ideas (resketch if necessary).

If you don't have time to complete this activity in one session, take a break here and come back later! Put the materials you collected and your Engineering Journal in a safe place until next time.

Step 8: Choose one design to try out (10 min.)

After brainstorming many different ideas, engineers choose one design that they will build and test. The chosen design combines the best elements of all their ideas. Before starting to build, they draw a detailed plan of their design, and list or label the materials they will use.

Using your Engineering Journal, draw a final plan for the design you want to build and test. Be sure to label your drawing and write down how much of each material you will need.

Step 9: Build and test your space capsule (15 min.)

Follow your plan and create your space capsule!

When you are finished, test how well your capsule works by using the testing methods in your Engineering Journal. Be sure to log the results of your splashdown in the third column of the table.

- *Did your capsule fail to meet any of the scoring criteria? Which ones?*
- *How did testing help you identify both the strengths and weaknesses of your design?*

Step 10: Learn from Failure (10 min.)

Engineers test and retest their designs so they can report on how well they work in various conditions. They are not afraid of failure! Sometimes, engineers will make their tests harder and harder just to see when and how their designs fail. If your space capsule failed to meet any of the scoring criteria, don't get discouraged. Think like an engineer!!

- *What can I learn from failure that will help me improve my capsule?*
- Try it from higher and higher heights until it fails.
- *Redesign, test, and share your modifications.*
- *Did it perform better?*

Step 11: Communication and participate (5 min.)

Engineers communicate their designs with others. They share their work with other engineers, with the clients that ordered their products, or with the general public.

Take turns presenting the results of your engineering work to a partner, group, or instructor.

- *Describe your design and the criteria you were trying to meet.*
- *Perform your test sequence to show how it works.*
- *Ask others to provide feedback on your design.*

Think about how you can provide good feedback to your peers.

- *I like how your design _____.*
- *One thing you might try is _____.*

Step 12: You are an Engineer! (5 min.)

Engineers solve problems by designing technologies and they use an engineering design process (EDP) like the one you used in this lesson. In this activity, you worked as an engineer to do the kind of work engineers do:

- You came up with a creative design for a space capsule.
- You solved a problem to help astronauts return safely.
- You brainstormed a number of different ideas.
- You tried to make the design better based on your results.
- You persisted through failure.
- You shared your ideas and solutions with others.

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