



Boat Float Engineering Design (Resource Exchange)

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Boat Float Engineering Design Challenge

Archimedes' principle states that when an object is placed in water, if the upward buoyancy force is equal to the weight of the water that is displaced, the object will remain stationary (achieving equilibrium). In this activity, students will apply this principle by working in small groups to construct a "boat," which is able to support a five-pound bag of flour, which models their passenger. Students will need to collaborate on this challenge, follow the steps in the engineering design process, and work under real-world constraints of time, resources, and an additional element in order to complete this challenge.



Grade Level: Designed for 8th grade students.



Goal: Apply what we have learned about engineering and empathy into a real-world problem-solving activity.



Estimated Time: 60 minutes - 120 minutes.

Materials/Resources:

Large plastic tub filled with water
Old (washed out) plastic bottles, cups, containers, etc.
Flour bag double-bagged in gallon ziplocks (to ensure it will stay dry)
8+ hot glue guns
Lots of hot glue refills
4 rolls of colored duct tape
Construction paper
12 pairs of scissors
Presentation on empathy and history (Titanic)
Timer for teacher
Engineering design notebooks
Towels
Red, yellow, and blue slips of paper to draw

Academic Language:

Engineering Design Process
Displacement
Density
Equilibrium
Archimedes' Principle
Empathy

Next Generation Science Standards: MS-ETS1-1

Engineering Design: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Students will be able to...

Collaborate with peers to complete an engineering challenge

Employ the skills they have learned about engineering and other skills to complete the task

Work under constraints and experience how constraints may affect an engineer's ability to complete a team task

Demonstrate empathy in the creation of their design or throughout their design process

Assessment:

Observations during the challenge

How well did the group collaborate with one another?
How do they decide what to revise and change?
Did students use the engineering design process?
Did they consider the passenger in their design? How?

Testing of the boats

Success/failure is not crucial, but how the students respond to these results?

Pay close attention to why it happened the way it did, because this demonstrates application of knowledge.

What do they change in their plans or talk about changing because of what happened/what they observed?

Pages completed in their design notebook

How thorough are their plans?
Do they collaborate while working through this aspect?

Equity Measures/Differentiation:

Students will be working in groups of three-four to help learn collaboration and allow for diverse ideas to be combined.

The focus is on applying the ideas of the process and creativity, not necessarily the success of the final project. This will take off some of the pressure that students may feel if they have low self-efficacy in this area of engineering and design.

Lesson Plan

Prep:

- Gather supplies
- Fill bucket with water

Grouping:

- Instruction will be given as an entire group.
- Design will begin individually in their lab notebooks and then revised and created in groups of three or four
- Testing and wrap-up will be conducted as a large group

Opening/Motivation: 5 minutes

- Review the EDP and how the students have employed that today

Presentation/Instruction: 15 minutes

- Talk about buoyancy and historical connections with it
- Talk to students about “finding their why.” Why do they want to learn more about this topic? Could we frame it in terms of “saving lives” since they’re designing lifeboats? Students may connect to learning about situations when lifeboats were needed and helped people survive, such as Costa Concordia crashing off the coast of Italy in 2012. Lifeboats saved lives that day. Talk to students about the importance of high-quality engineering for lifeboats
- Present the challenge goals
- Explain the steps and timetable for the rest of the challenge
- Break into groups of three or four
- Introduce variable

Contingency Plan:

Students will work in small groups to collaborate with one another. Those that finish early are encouraged to add additional creative elements or to consider what would happen if we altered the constraints (either weight of the cargo or the size of the container) and how that would have affected their plan.

Additional Resources

https://www.teachengineering.org/activities/view/duk_boat_mary_act

<https://www.scholastic.com/teachers/articles/teaching-content/activity-plan-5-6-build-boat-floats/>

https://www-tc.pbskids.org/fetch/parentsteachers/activities/pdf/FETCH_FloatMyBoat_AG.pdf

Structured Practice:

10 minutes

- Collaboration with partner(s). Must present final design before using materials. Have to spend 10 minutes planning without touching materials. Must build exactly what is on their design
- Write 1-2 sentence rationale for why their design will work
- Prototype Boat

10 minutes

- Testing Boats

10 minutes

- Must draw a new plan and then can make revisions

10 minutes

- Talk about the importance of “failing forward” in all areas of life. Engineering can help us learn this life skill and can also help us to better empathize with people in our lives after they fail
- “Failure is not the opposite of success; it’s part of success.” Arianna Huffington, founder of the Huffington Post
- Discuss with students why it’s important for lifeboat prototypes to be tested. What could happen if they weren’t?

Closure: 10 minutes

- Final test: Students say why they think their design will work or what improvements they made before testing

Additional Notes:

Encourage students that their “boats” do not need to look like real boats that we see out in the water, they just need to be functional and innovative for the task at hand.

Teacher should encourage students that not all materials will be available and that they will need to creatively problem solve. Reiterate the Engineering Design Process, and most especially emphasize the importance of planning in this situation!

Notice how students are communicating with one another, team dynamic, and what they are collaborating on. How do the given constraints impact this communication?

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