Build a Boat for Scientific Research

Timeframe

1-2 Fifty minute class periods

Target Audience

Elementary School (4th- 6th)

Materials

- Aluminum foil
- Tape
- Clay
- Straws
- Skewers
- Pipe cleaners
- Popsicle sticks
- Corks
- Cups

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Description

Students will take part in a hypothetical challenge that will help them to better understand the process of engineering and designing a boat for scientific research.

Objectives

Students will:

- Apply an understanding of buoyancy
- Design a boat that floats while carrying a lot of weight
- Decide which design will best meet the given boat parameters

Guiding Questions

- How do you get a boat to float with heavy equipment?
- How can you make your boat stable so that it won't sink with a heavy load?

Background Information

The most crucial part of an ocean going venture is most certainly the vessel itself. A boat is an island unto itself once it leaves the safety of its dock and heads out on the open seas. Any ship, no matter what its size, must carry all of the supplies and equipment that its crew will need to live safely for the extent of the voyage.

In the case of research vessels, the vessels must also be equipped with special tools and technology that allow scientists to explore ocean environments. Research vessels are highly advanced traveling research stations. They must be able to offer scientists stable platforms from which they can deploy equipment, divers, and submersibles. In addition, these vessels carry electronics, computers, and navigational and communications systems.

For additional information and resources around ocean exploration and research vessels go to the **NOAA Okeanos Webpage**.

How is that ships carrying such heavy loads are able to float? Archimedes Principle can help explain this. The Archimedes Principle came from the Greek scientist named Archimedes who discovered the scientific law of buoyancy. Archimedes figured out that if the weight of the object being placed in the water is less that the weight of the water displaced, the object will float. An object will float if it displaces as much water as it weighs. This is known as buoyancy or the Archimedes Principle. A ship made out of metal is able to remain lighter than the amount of water it displaces, because it is not a complete solid. The very bottom of the ship is hollow and therefore adds support to the ship without adding any mass. When a ship is fully loaded, there is a maximum amount of weight it can carry before the weight of the ship increases past the amount of water it displaces.

Activity Introduction

Demonstrate buoyancy to students by giving them a ball of clay. Ask: What do you predict will happen if you put this clay into the water? (It will sink) Now have students make the same piece of clay into the shape of a boat. Have them predict what will happen when it is put in water. (It should float)

Ask students to share their ideas about what caused the clay to sink or float. Let students know that whether something sinks or floats is determined by density, which has to do with weight (mass) and size (volume) together. If the density is greater than that of water, the object will sink. If the density is less than (or the same as) that of water, the object will float. Even if boats are made of things that sink they can float IF THEY ARE SHAPED RIGHT (which was the case for the clay boat).

Activity

1. To introduce students to the various forms and functions of boats by showing them pictures of various types of boats (see PPT slide). Ask:

   -Why do boats have different shapes?
   -Which of these boats would be the most stable? Support the most weight? Travel the furthest? Be the fastest? Slowest?

Next Generation Science Standards

DISCIPLINARY CORE IDEAS:

ETS1.A.: Defining and Delimiting Engineering Problems
ETS1.B.: Developing Possible Solutions
ETS1.C.: Optimizing the Design Solution

PERFORMANCE EXPECTATIONS:

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 are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

SCIENCE AND ENGINEERING PRACTICES:

Asking Questions and Defining Problems
Developing and Using Models
Constructing Explanations and Designing Solutions

2. Tell students that there are many ways to build a boat depending on what your goals are. Let them know that their boat is going to be for scientific research. What would a boat that is used to study the ocean need? Introduce them to **Oregon State University's ships** and talk about the various types of research that is done on these vessels. Show students the **VIDEO** of the design plan for OSU's soon to be built Regional Class Research Vessel.

3. Break students into groups of 3-4 and provide them with a limited amount of materials to build their boats with (example: 1 6x6 piece of aluminum foil, 1 foot of tape, 4 popsicle sticks, 1 straw, 2 pipe cleaners, 1 cube clay, etc.). You will also give them a bag of assorted materials that represent people, equipment, and supplies that their boat must carry.

4. Give students the Boat Design Challenge Student Handout and have the group take turns reading it out loud to each other and then discuss. Let students know that they must first create their design on paper before building their models. Have them think about what kind of boat their group will want to design based on the parameters that have been given.

5. Now students can build their models! After they complete their build they will test them in a provided tank (use a long Tupperware container) and compare their boat design to the other designs. Have students record observations of their boat and other boats. What worked? What didnt work? Give students a chance to re-engineer their designs.

Wrap Up

Ask students to share which boat was most successful and why.

- What was difficult about designing and building your vessel?
- What would you change about your boat design and why?

Resources

http://mocomi.com/buoyancy/
http://oceanexplorer.noaa.gov/technology/vessels/vessels.html
http://ceoas.oregonstate.edu/ships/

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Boat Design Challenge- Student Handout

The Problem

The International Commission for Ocean Exploration (ICOE) has a number of boats that do world class research and are used by many. More than one of their current research boats is getting old and needs to be replaced. The ICOE is looking to contract with a boatyard to build a number of new and modern boats. The new boats will be used for long trips on the ocean to collect scientific data which means that boats will need to have adequate space and carry a heavy load.

The Challenge

The ICOE has contacted your boatyard to create a boat design plan and a model vessel. You will then present your plan to the ICUE and tell them why they should choose your boatyard to build the boat. Your boat design must show the following:

- **Deck Space:** sufficient deck space for carrying materials
- **Indoor Space:** sufficient wheelhouse space for labs, sleeping accommodations, and food
- **Stability:** is able to carry the most amount of weight and be stable in rough water

IMORTANT INFORMATION YOU NEED TO KNOW BEFORE YOU BEGIN

1. There are limited resources available for you to use to build your boat:
    - ✓ Sheet metal (6x6in piece aluminum foil)
    - ✓ Welding material (1 foot of tape)
    - ✓ Wood (4 popsicle sticks)
    - ✓ Reinforcements (1 straw)
    - ✓ Cable (2 pipe cleaners)
    - ✓ Fiberglass (½ in clay cube)
    - ✓ Wheelhouse (1 small cup)
2. You have been given a bag of materials that represent people, equipment, and food and must accommodate them on your deck and in the wheelhouse.
3. You will load as many pennies as you can onto the deck of your boat. The most successful designs will hold the most pennies without sinking.
4. You must draw a design of your boat before you begin building your model.

Testing Observations

Once your group has completed your model you will have a chance to test it and compare with other models. You will then have a chance to redesign and rebuild your model. Observations are an important part of understanding what worked and what didn't work. Record your observations in the space below:

Boat Design Plan

Discuss with your group:

1. How will you make a boat that floats well enough to support a heavy load without sinking?
2. Should your boat be a platform (e.g., a raft or barge) or an open boat (e.g., a rowboat or canoe)?
3. How big do you need to make your boat to include room for people, equipment, food, etc.?

Draw a detailed boat design that includes location of: wheelhouse, deck, equipment, and pennies.

Design 1

Design 2