OneWatershed

Ocean Engineering Lesson | *Build-A-Buoy*

6E Lesson Plan and Teacher Prep

Instructor:

Grade/Class:

Overview

Big Idea: What challenges do engineers face when designing devices for ocean use?

Driving Question: How can a payload be maximized on a buoyant device?

Abstract: This engineering activity explores buoyancy and ocean engineering through a hands-on challenge.

Lesson Objectives: TSWBAT (1) demonstrate an understanding of an object's center of gravity and buoyancy, (2) create a buoyant buoy, and (3) differentiate between a channel marker and basic observation buoy.

Time: 120 minutes

Materials: The following list includes the materials needed per team. This activity is designed to have students competing and recommends you acquire multiple sets of these materials to accommodate competition.

- PVC Pipes:
  - Bucket of 1½" (50mm) by 6" (160mm) PVC Pipe
  - Bucket of 1½" (50mm) 90° Elbows and Ts
  - Bucket each of ½" (20mm) 3-way, 4-way, elbows, and T-connectors
  - Bucket of ½" (20mm) by 6" (160mm) PVC Pipe
- Plastic Discs (Frisbees) with four ½" (20mm) holes drilled at edge
- 10 – 12" (30cm) Reusable Plastic Cable Ties
- Scissors or snips
- Golf balls
- Baby pools
- Indoor/outdoor thermometer
- A premade 'decoy buoy'

Ocean Literacy Principles: OLP-7 The ocean is largely unexplored; OLP-6 The ocean and humans are inextricably interconnected.

NGSS Crosscutting Concepts: (6) Structure and function

NGSS Practices: (1) Defining problems; (3) Planning and carrying out investigations; (6) Designing solutions; (7) Engaging in argument from evidence; (8) Obtaining, evaluating, and communicating information

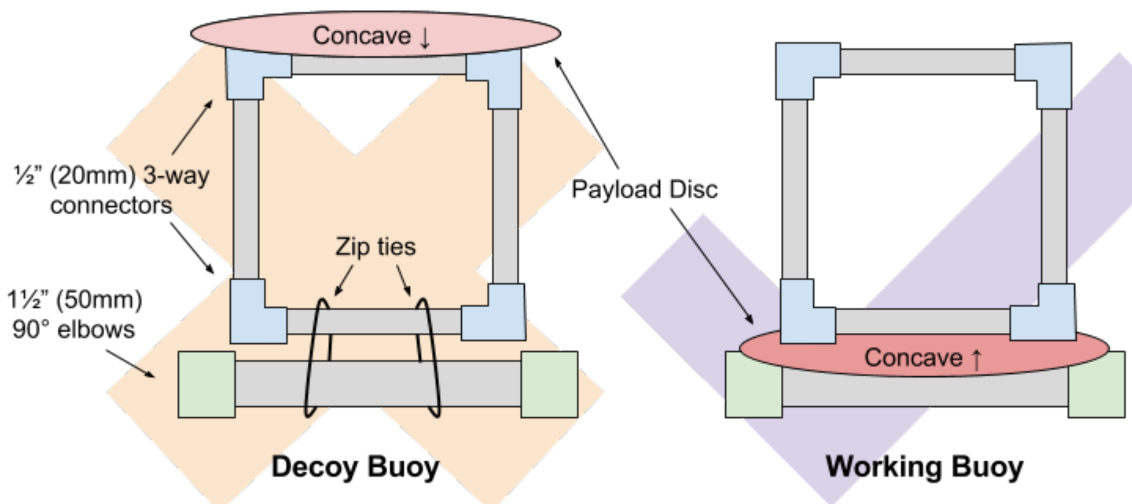
NGSS Performance Expectations: 3-5-ETS-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost; MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions; HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Preparation

Time: 20 minutes

Materials: twelve ½" by 6" PVC pipes (see Materials Overview for mm), eight ½" 3-way connectors, four twelve 1½" by 6" PVC pipes, four 1½" 90° elbows, plastic disc with four ½" holes, cable ties

Create a 'decoy buoy' using the diagram below. This buoy is displayed to encourage creativity.



Have all materials on display to engage students as they approach activity site.

Engage | *World Records*

Time: 10 minutes

Inquiry-based Context Setting: With the materials displayed, ask students, "What do you think we are doing today?" Then ask, "What are buoys? And what types of buoys are there? Why are buoys in the water?"

Students are challenged to beat the 'world record' by designing a small buoy that can carry the largest payload. For elementary students, the 'world record' is 20 golf balls.

Basic Criteria:

1. Buoys must float.
2. They must hold a payload (golf balls).

3. Buoys must be visible from the water. For Middle School and High School, the buoys should be 1 meter tall.

Explore | *Channel Markers*

Time: 30 minutes

Follow these steps to complete this lesson's exploration phase.

1. Divide the students into pairs or teams of three.
2. Teams choose their PVC pipes, pre-cut plastic discs, and plastic cable ties, and construct a buoy, following the criteria provided using the engineering design process.
3. At any time during the process, students are encouraged to 'test' their model by adding the golf ball payload to their design. Expect students to improve upon their design until they set the world record.
4. When all teams create successful designs, gather them in a circle with buoys displayed.

Note: Watch for student frustration levels. If they are not being successful, offer hints for improvement as needed.

Explain | *Density and Buoyancy*

Time: 15 minutes

Constructing Explanations and Designing Solutions: Ask your students why some buoys float and others do not. Ask, "Did your final product match your original design?" Have each team share the modifications and changes they made to improve their buoy design.

Then review the following terms: density, buoyancy, and center of gravity.

Elaborate | *Basic Observation Buoys*

Time: 15 minutes

Convert marking buoy into a basic observation buoy. Distribute the indoor/outdoor thermometers and instruct the teams to create a basic observation buoy (BOB) that measures the temperature of the water and air.

Knowledge Activation: Ask, "Why would we want to measure the temperature of the air and water?" And, "If the temperatures are different, why are they not the same?"

Note: Do not get the thermometers wet.

Evaluate | *The Engineering Process*

Time: 15 minutes

Crosscutting Concept: "How does the structure of a buoy impact its function?"

Have them return to their original design and evaluate, either through descriptions or drawings, the changes they made and the challenges they faced. For Middle

School and High School classes, ask students to evaluate their process.

Assign costs to the pieces of PVC and cable ties. Have your students calculate the total cost of their buoy (including any cable ties used) and share the costs and results with the class.

Empower | *Our Environmental Impact*

Time: 15 minutes

Context Setting for Action Plan: Distribute pieces of paper and instruct students to design a buoy, equipped with different sensors that can be used to measure water quality and air quality. Ask students, “How much do these sensors cost? How will your buoy be powered? And how will you access the data it collects?”

Establish the connection between buoy data, land use, and changes in water quality. Step students into thinking of their role in ecosystem wellness.

References

Douglas R. Levin, PhD designed the *Build-A-Buoy* program, the basis for this lesson.