Notes

Introductory Activity

Objectives

The students will:

- draw their perception of what an engineer is
- reflect on their perception versus actual engineering professions

Background Information

Introductory Activity is a lesson that focuses on the student's perception of what is an engineer.

Inquiry Overview

Students will depict their thoughts of what an "engineer" is by constructing a drawing. Students will reflect on their perceptions. At the end of the unit, students will revisit their drawings and you may choose to have them redraw "engineer" at the end.

Activity:

- 30 Minutes: Introduction and Drawing
- 40 Minutes: Sharing
- 20 Minutes: Debrief

Materials

For Each Student

- Student Handout

For Students to Share

- Colored Pencils/Markers

Students are asked to draw an "engineer doing engineering work."

By having students draw what they imagine an engineer to be and do you will employ an abstract method of determining what their perceptions are of the field.

After debrief, you may wish to display the drawings throughout the curriculum, revisit the drawings and initial perceptions, and have students modify or make new drawings at the end of the curriculum.

Debrief – Large Group

After the students have had ample time to complete their drawing, discuss the following points with the group.

- What are some similarities you noticed among the drawings?
- As a class, brainstorm a list of actions performed by an engineer.
- As a class, brainstorm a list of objects used by engineers
- What are some problems that engineers could help solve?

Build-A-Boat

Notes

Objectives

The students will:

- understand and practice scientific inquiry: questioning, predicting, observing, recording and interpreting data, and communicating results.
- experience the concept of buoyancy
- explain in their own words why some objects sink and other objects float
- design and construct an aluminum foil boat that can hold a maximum load

Standards

SEP1	SEP8
SEP2	MD.A.2
SEP3	G.A.2
SEP4	NS.C.5
SEP5	SP.A.1
SEP6	MP2
SEP7	MP5

Background Information

Build-A-Boat, is a lesson that focuses on the engineering design process and the concept of buoyancy.

Buoyancy is the upward force a fluid puts on an object less dense than the fluid itself. The buoyancy of any object in water depends on the amount of space the object takes up or its volume and density--how much mass it has per unit of volume--compared to the density of the water. Objects with large volumes and low densities tend to be quite buoyant. For example, ships are buoyant in spite of the fact they're often made out of metal. That's because the hulls of ships are usually filled with air, which is less dense than water

When an object is placed in water there is a buoyant force that pushes up on it. The strength of the upward force is equal to the weight of the water that was moved out of the way or displaced. As a result, if an object moves a small amount of water out of the way, then the weight of the small amount of water is small, thus the buoyant force is small. In contrast, if the object moves a large amount of water then the weight of the water is large and there is a large buoyant force pushing up on it.

Inquiry Overview

Throughout this lesson, students are learning how to question, predict, observe, record and interpret data, as well as communicate results, all the while learning and experiencing the effects of buoyant forces.

Notes

Advanced Preparation

Bring in tubs for water and decide how/where tubs will be set up for boat testing.

Activities:

Initial Exploration

- 10 Minutes: Introduction of Activity
- 40 Minutes: Design and Build
- 10 Minutes: Debrief

Big Load

- 10 Minutes: Introduction of Activity
- 40 Minutes: Design and Build
- 10 Minutes: Debrief

Biggest Load

- 10 Minutes: Introduction of Activity
- 90 Minutes: Design and Build
- 20 Minutes: Debrief

Materials

For the class

- Tub(s) of water
- Pennies
- Scissors
- Scale
- Dry rice
- Graduated Cylinder
- Graph paper
- Ruler
- Computer with Internet Access

For 2 students per group

- Aluminum foil
- Tape

Students are arranged in groups of two. Each pair will receive the same set of materials. Teams may only use the materials and quantities provided. Introduction activities provide students the opportunity to explore and experiment with density and buoyancy. Following the initial exploration activities, students will progress to designing their boats. Allow teams enough time to research, plan and construct their boats. Before testing, collect all boats (be sure that students label which boat is theirs') and have each team estimate how many pennies they think that their boat will hold. During testing select one student per team to add the pennies. Use your own judgment as to how long to wait in between adding more pennies. Do not allow students to just dump pennies on their boats as this may cause an unfair advantage.

Teacher tip: As the maximum load nears you may want to slow down the penny addition and allow more time for observations.

Teacher Suggestion: You may choose to have multiple "tubs" of water set up around the classroom. These tubs could have specific and/or creative names such as "Lake Michigan" or "Fusion BAY"

When the time is right you may choose to show the students the following video clip from PBS. The video clip describes in simple terms buoyancy and what happens to the buoyant force if the boat is sinking. Link:
http://www.pbs.org/media/wgbh/designsquad/animations/202_bouyancy_hi.mov

Notes

Debrief – Large Group

- How did you place the pennies in your boat? Did you have a strategy? Why did you use this strategy?
- What would you change if you had to do this challenge again?
- What was the most effective boat design? Why?

Extensions

- Build and test several styles of boats using the same amount of aluminum foil.
- Measure and record level of water displacement as pennies are added.
- Use other materials, such as, wax paper, plastic, or cardboard to construct the boat.
- Use other materials to place inside the boat, such as gummy bears or sour patch kids.
- Cardboard boat race: Use recycled cardboard to construct a boat that would hold a heavy object (for example: a brick or cinder block). Race them in a local pool.
- Wrap pennies with foil and drop them into containers of water with various temperatures. Watch as the pennies drop at different rates.
- Build a boat using straws and plastic wrap. Link: http://pbskids.org/designsquad/parentseducators/resources/watercraft.html

Resources

Interesting Article: http://www.sciencenewsforkids.org/2011/05/ants-aweigh/

Build-A-Boat

TRY IT & REPORT

Materials Needed: Two pieces of aluminum foil (15 centimeters by 15 centimeters) and one tub of water.

Shape a piece of aluminum foil into a design that will float. Draw the shape below.

Shape a piece of aluminum foil into a design that will sink. Draw the shape below.

When your team is ready, take the shapes to the tub and try them out.
What happened? Was it what you expected? Write your response below.

Build-A-Boat

PROCEDURE:

1. Shape a 15cm by 15cm piece of aluminum foil into the designs listed in the table.
2. Use a new 15cm by 15cm piece for each foil shape.
3. When your team is ready, take the shapes to the tub and observe the outcome.

TRY IT: Does it sink or float?

FOIL SHAPE	My Prediction!	What do you observe?		Why do you think that is happening?
		SINK	FLOAT	
FLAT				
FLAT WITH PENNY ON TOP				
BALL				
BALL WITH PENNY IN MIDDLE				

Build-A-Boat

DESIGN: Use the materials provided to design a boat that can hold **at least** 10 pennies.

MATERIALS:

For the class	For each student group
Tub (Clear)	Pennies
Water	1 Aluminum foil sheet (15cm by 15cm)
Scissors	

PLAN & SKETCH:

How will your boat look? Sketch your plan for building the boat in the space below.

RESULTS: When your team is ready, take the shape to the tub and test its performance. What happened? Was it what you expected? Write your responses below.

Build-A-Boat

CHALLENGE: How can your team design a "boat" that will hold the **most** pennies using the materials provided?

MATERIALS:

For the class	For each student group
Scale	Pennies
Tub (Clear)	1 Aluminum foil sheet (15cm by 15cm)
Water	Scissors

PLAN & SKETCH:

We will consider the following factors in our boat design. Sketch your boat in the space below.

WEIGHT: Your team needs to come up with a plan to answer the following question –

How much weight did the boat hold? Explain how your team will do this using pennies as cargo.

Build-A-Boat

RESULTS: When your team is ready, take the shape to the tub and test the boat. What did you notice as you added the pennies? Describe your results below.

CALCULATIONS:

Calculate the total weight of the pennies your boat held? Show your work!

Build-A-Boat

CLASS DATA TABLE:

Record your maximum capacity on the class data table below.
Collect data from the entire class. Use this data to help you decide

TEAM NAME	MAXIMUM # PENNIES HELD

Build-A-Boat

Class Observations and Data		
° Boat Drawing ° Number of Pennies ° Weight Held ° Other Observations	° Boat Drawing ° Number of Pennies ° Weight Held ° Other Observations	° Boat Drawing ° Number of Pennies ° Weight Held ° Other Observations

Build-A-Boat

DISCUSSION:

1. How did you place the pennies in your boat? Describe your strategy.

2. What would you change about your boat and/or penny placement strategy if you were able to do this challenge again? Explain your ideas.