Web Unit Plan

Title: Float That Boat

Description: We B Toys just completed their annual customer satisfaction reviews of their toy boat line. They have learned that customers have complained that their boats tend to sink. They are looking for new toy boats and are offering to purchase $1 million worth of merchandise to the company that produces the best boat. Student teams design new boats that will float and prepare proposals to market their boats.

At a Glance

Grade Level: 3–5

Subject sort (for Web site index): Science

Subjects: Physical Science

Topics: Properties of Matter

Higher-Order Thinking Skills: Problem Solving, Generalizing, Investigating

Key Learnings: Density and Buoyancy, Experimental Design, Measurement, Persuasive Speaking

Time Needed: 3 weeks, 45–60 minutes daily

Background: From the Classroom in Texas, United States

Unit Summary

After investigating density, displacement, and buoyancy in hands-on experiments, students take on the role of designers to create boats for We B Toys. Students create brochures or multimedia slideshows to persuade We B Toys to consider their boat designs for a new line of toy boats.

Curriculum-Framing Questions

- **Essential Question**
  How can we explain the things that happen around us?
- **Unit Questions**
  Are there rules that affect the ways things move?
  What rules affect whether an object floats or sinks?
- **Content Questions**
  How are density, buoyancy, and displacement related?
  How can you measure volume of irregular solids?
  Which objects float and which objects sink?
  What happens to liquids when objects float or sink?

Assessment Processes

View how a variety of student-centered assessments are used in the Float That Boat Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Posing Questions and Eliciting Prior Knowledge

Introduce the Essential Question, *How can we explain the things that happen around us?* Ask students to brainstorm their thoughts, examples, and ideas, and record their responses on a chart. Keep this chart to refer to as the unit unfolds. Then ask students to consider the following questions:

- *Are there rules that affect the ways things move?*
- *How can we find out?*

Guide students in a class discussion highlighting scientific method and engineering process components as they arise. Do not worry about having all components during this initial discussion. The following chart is for reference and can be used as a template for anecdotal notes for recording student ideas or given as a handout after the discussion.

The Scientific Method	The Engineering Process
State the question	Define the need
Conduct background research	Conduct background research
Formulate hypothesis, identify variables	Determine design criteria
Design experiment, determine procedure	Prepare initial designs
Test hypothesis by conducting an experiment	Build and test a prototype
Analyze results and draw conclusions	Test and redesign as necessary
Present results	Present results

Introduce the topic of the unit by asking, *Why does a huge ship float but a nail sink?* and *What rules affect whether an object floats or sinks?* Ask students to discuss their hypotheses and ideas in groups, and record their hypotheses in their unit journals. Tell students that they will be investigating these hypotheses throughout the unit to help them design boats.

Review student journals to assess prior knowledge students have about buoyancy and density. Differentiate instruction based on student hypotheses. Periodically throughout the unit, review the journals to assess how well students understand the content, and redirect teaching as needed.

Background Information

Have students start to investigate some of the rules that affect whether an object floats or sinks.

For each group, provide a big tub of water and several objects that float and sink (wood, rocks, coins, nails, crayons, polystyrene cups, eraser, paper clip, marble, small piece of plastic, and so forth). Ask students to predict which of the items will sink and which will float. Then test the waters. Have students record in their journals in a simple T-chart the items that float and those that sink. Brainstorm as a class the properties of objects that float and objects that sink, and record on a chart. Introduce the word *density* to describe the differences. Whether an object sinks or

floats depends on the density of the object in relation to the water. The heaviness of an object compared to its size is called its density.

Water Displacement and Buoyancy Activities

Ask students, *What happens to liquids when objects float or sink? Is there a difference? How can we measure what happens?*

Lead a discussion of ideas and then demonstrate measuring volume of a liquid using graduated cylinders and measuring volume of an irregular solid using volume displacement. The standard experiment uses a rock that can be suspended from a string or slid into a graduated cylinder. When the rock sinks, it pushes some of the water out of the way (displaces the water). The volume of the water displaced is equal to the volume of the rock. Graduated cylinders are generally used to measure how much water is displaced. The amount water rises when a rock is added shows the volume of the rock.

Have students practice measuring the volume of irregular solids using volume displacement. Provide each group a container of water, graduated cylinders, and the sinker objects they tested for the floating and sinking activity (marbles, coins, nails, rocks, and so forth). Ask students to record their measurements in their unit journals.

Bring students together and discuss how they just measured the displacement of water with objects that sink. Introduce the Displacement worksheet by asking, *What happens to liquids when objects float? Is water displaced?* Ask the students to make predictions and then work with a partner to complete the activity.

Based on their observations and measurements, lead the class in a discussion of the relationship between density and displacement. Introduce the word *buoyancy* as students describe their observations. Look at Buoyancy Basics* for a good demonstration of this concept. As a wrap-up for the day, ask the students to answer the question in their journals, *How are density, buoyancy, and displacement related?* Read journals to check for student understanding. If many students are struggling with understanding the concepts, use time the following day to continue investigating these concepts with the class.

Liquid Densities

Ask students if all liquids are the same. Have them explain how liquids differ. Using the Liquid Densities worksheet, ask students to explore liquids with different densities.

In groups, ask students to consider the question, *Will different liquids have an effect on whether an object floats or sinks?* Have each group share their thoughts and reasoning with the class. Provide each group with a small piece of wood, small piece of plastic, nail, and eraser from the floating and sinking activity as well as the jars they just created in the Liquid Densities activity. Ask students to return to their T-charts to find which objects floated and which sank in water. In a new table, ask them to write down which objects are more dense/less buoyant and which are less dense/more buoyant than water. Have students drop the objects in the liquids and record their observations in tables. An example table follows.

Density/Buoyancy Comparison

	Water	Oil	Corn Syrup
Wood	Less dense/more buoyant		
Eraser			
Plastic			
Nail			

Have groups report to the class about one interesting discovery.

Pose the question, *Will ocean water or bubble bath affect buoyancy?* Provide tubs of liquids—one with salt water, one with bubble bath, and one with plain water. Also provide several objects that float and sink. Ask students to compare the results with plain water to see if the density of these liquids affects buoyancy. Have students add their observations to their tables.

Wrap up the day by asking students to record their answers to the Unit Question, *What rules affect whether an object floats or sinks?*

Lead the class in a discussion of the rules they have discovered that affect whether an object sinks or floats. Record the rules on a T-chart. Have students return to their initial hypotheses and discuss in groups any that have not been answered. Have groups share hypotheses that still need to be tested and add these to the other side of the T-chart. Circulate through the room as groups discuss, taking anecdotal notes. Refer to these notes to help students needing further clarification or additional instruction. Lead a discussion emphasizing the scientific method they have used so far and the engineering processes that still need to be investigated to answer some of their remaining questions.

Foil Boats Activity

Shape will probably be one of the questions the students would still like to consider. In the Foil Boat activity, have students observe additional properties of buoyancy as they experiment with foil to create a shape that will float.

At the conclusion of this activity, tell students that they can continue to answer some of their remaining hypotheses for extra credit because the class is now going to move on to the challenge. As homework, ask students to explain in their unit journals why a huge ship floats but a nail sinks.

Introducing the Challenge

Introduce the challenge for the unit by describing the following We B Toys scenario:

> *We B Toys just completed their annual customer satisfaction reviews of their toy boat line. They have learned that customers have complained that their boats tend to sink. They are looking for new toy boats and are offering to purchase $1 million worth of merchandise from the company that produces*

the best boat. Your job is to design a new boat that will float and prepare a proposal for a new toy boat line.

Assign students into heterogeneous groups and introduce them to the following project steps:

1. Brainstorm types of materials as well as designs to create a toy boat.
2. Use the brainstormed list to create a few prototypes that display the best ideas using the Design that Boat! worksheet.
3. Redesign and construct new boats based on tests.
4. Analyze the prototypes and select the best model to present to We B Toys.
5. Form "companies" with a company name and marketing theme.
6. Develop a brochure or multimedia presentation to present to We B Toys representatives.
7. Use the marketing checklist and project rubric to guide the process.

Discuss the requirements and assessment criteria, and check for student understanding. Allow time for teacher and peer conferences while student groups are working to receive feedback to strengthen their projects. Have students use the collaboration rubric to assess the group's collaboration skills.

Invite guests from local toy stores or from the school community to the presentation as "representatives" of We B Toys. Assess the presentations using the project rubric.

Wrapping Up

At the end of the unit, revisit the Essential Question, *How can we explain the things that happen around us?* Ask students to record examples from their testing and experimentation in their unit journals as they explain what they have learned during the unit of study.

Prerequisite Skills

- Basic mass and volume measurement skills
- Working knowledge of desktop publishing software and multimedia slideshow software
- Working knowledge of word processing skills

Differentiated Instruction

Resource Student

- Allow extended computer use
- Provide a brochure template
- Break assignments into small, manageable segments and write them on a checklist
- Use a teacher assistant or instructional aide
- Arrange partnering with another non-resource student

Gifted Student

- Challenge the student to master complexity within applications as well as analyze and synthesize learning
- Enlist the student to use leadership skills to organize and focus the group
- Encourage the student to include more advanced technical attributes in the brochure
- Have the student exchange correspondence with a toy or boat building company
- Encourage the student to make arrangements for a guest speaker
- Have the student complete a class Web site that showcases class learning

English Language Learner

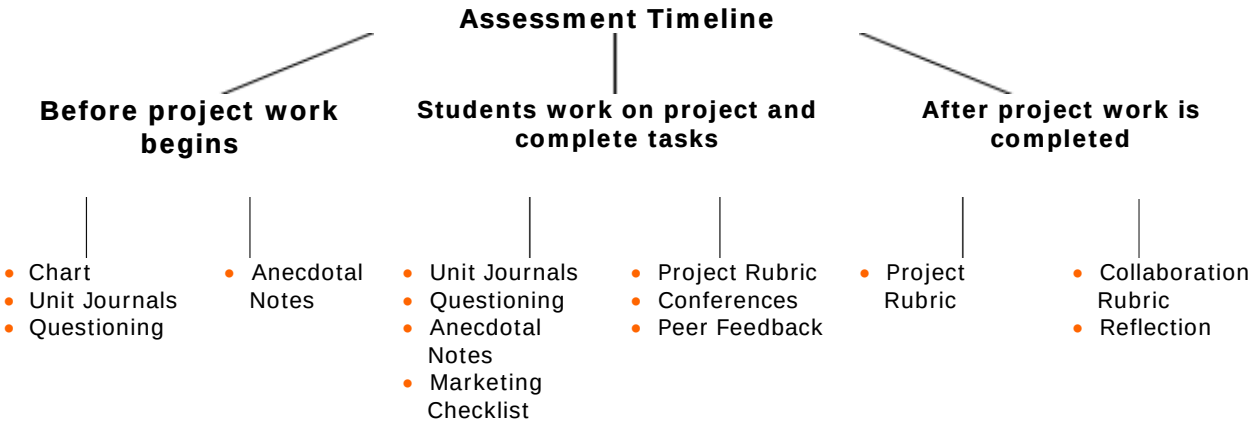
- Pair the student with native English speakers to assist in project work
- Use visual aids
- Allow for work to be done in the student's first language and then get a translation

Credits

Teresa Kester participated in the Intel® Teach Program, which resulted in this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

THINGS YOU NEED (highlight box)

Assessment Plan



Assess students throughout the unit using questioning strategies and taking anecdotal notes of responses and behaviors. Review questions posed at the beginning and end of activities in the students' unit journals and adjust instruction as necessary. Circulate through the room as students participate in group discussions and activities, monitoring understanding, probing thinking, and gathering information on individual and collaborative skills.

Provide the marketing checklist to give students an opportunity to brainstorm ideas and ensure all required elements are present. Ask students to refer to the project rubric as they develop their presentations, and use both teacher and peer feedback to provide each group with information to revise their projects before the final presentation. Assess the presentations and brochures with the project rubric for content, presentation, and organization. Students use the collaboration rubric to provide feedback on their group members' collaboration skills. As a final assessment, review student answers to the Essential Question, *How can we explain the things that happen around us?*

Content Standards and Objectives

Targeted Content Standards and Benchmarks

Texas Essential Knowledge and Skills for Science
Grade 4
The student:

- Conducts field and laboratory investigations following home and school safety procedures and environmentally appropriate and ethical practices
- Uses scientific inquiry methods during field and laboratory investigations
- Uses critical thinking and scientific problem solving to make informed decisions
- Knows how to use a variety of tools and methods to conduct science inquiry
- Knows that matter has physical properties

Student Objectives

Students will be able to:

- Understand the properties of density, buoyancy, and displacement
- Measure volume of irregular objects through displacement
- Develop and test hypotheses about variables that affect the buoyancy of boats using the scientific method and engineering process
- Analyze data and draw conclusions
- Use various written and visual presentation tools to effectively communicate learning
- Use persuasive speaking to convince audiences of the superiority of a product
- Work cooperatively in small groups

Materials and Resources

Printed Materials

Buegler, M. E. (1988). *Discovering density (grades 6–9)*. Berkeley, CA: University of California at Berkeley, Great Explorations in Math and Science (GEMS) Project.

Gibson, G. (1995). *Making things float and sink*. Brookfield, CT: Copper Beech Books.

Glover, D. (1993). *Flying and floating*. New York: Kingfisher Books.

Science and Technology for Children (STC). (2002). *Floating and sinking*. Burlington, NC: Carolina Biological Supply Company.

Supplies

- Several objects that float
- Several objects that sink
- Beakers (or other containers) of water
- Graduated cylinders
- Aluminum foil
- Paper clips
- Film canisters
- Small masses (such as coins, marbles, nails, rocks, and so forth)
- Balances or scales
- Several sinks or containers for water
- Cooking oil
- Corn syrup
- Bubble bath
- Salt
- Red and blue food coloring
- Various materials that could be used to build boats

Internet Resources

- ExploreLearning, Gizmos
  www.explorelearning.com*
  Interactive density labs
- MadSci Network
  www.madsci.org/experiments/archive/869327658.Ph.html*
  Buoyancy lesson
- NYU: Science Teachers Enhancement Model, Exploring Density
  www.nyu.edu/projects/mstep/lessons/density.html*
  Background information for teachers
- Bill Nye's Buoyancy Lab
  www.billnye.com/episode_pdfs/episodeguide5.pdf*
  Episode on buoyancy under physical science

Technology—Hardware

- Computers for conducting research and creating multimedia and publishing documents
- Projection system to share multimedia presentations with We B Toys representatives
- Digital cameras to take pictures of prototypes

Technology—Software

- Desktop publishing for designing brochures
- Encyclopedia on CD-ROM for accessing information about vocabulary and boats
- Image processing to process pictures for presentation
- Internet Web browser for conducting research
- Multimedia for designing multimedia presentations
- Word processing for creating written work