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BASIS Lesson Plan

Lesson Name: Buoyancy: Who Sank the Boat?

Grade Level Connection(s)

NGSS Standards: Kindergarten Physical Sciences

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

What makes an object sink or float? In this presentation, we use the very funny children's story Who Sank the Boat? by Pamela Allen to explore some basic concepts about buoyancy. Children will make observations and conduct simple experiments to draw conclusions about why some things float while others don't. Using model boats in a model bay, we will try to find out who really sank the boat!

Lesson Objectives

- Students will better understand the concept of buoyancy.
- Students will use basic modeling techniques to bring scientific concepts from a storybook to life.
- Students will make observations and use evidence to make predictions and claims about buoyancy.
- Students will better understand that the material, shape, and stability of an object all affect the object's buoyancy.

Vocabulary Words

- **Buoyancy:** an object's ability to sink or float
- **Bay:** a part of the sea that is mostly surrounded by land.
- **Material:** what something is made out of
- **Stable:** not likely to tip over
- **Observation:** something you see, hear, or notice
- **Prediction:** guess based on things we know or observe (evidence)

Materials

- Who Sank the Boat? by Pamela Allen
- Large plastic bins (3; filled with water in classroom)
- Hand towels (3)
- Supporting images of the bay or other bodies of water
- Extra pieces of aluminum foil

Activity #1 (3 sets each with the following materials)

- Ping pong balls (10)
- Marbles (10)
- Bottle caps (10)
- Clay in small balls (7)

Activity #2 (3 sets each with the following materials)

- Pieces of aluminum foil (10)
- Pennies (~70)

Activity #3 (3 sets each with the following materials)

- Small aluminum bread pans (5 ¾ in x 3 ¼ in x 2 in)
- Pennies in tall plastic containers with laminated images of animals from Who Sank the Boat?

Classroom Set-Up

Before starting with the presentation, the plastic bins will be filled with water to an appropriate depth. Each station will be supplied with everything needed for Activity #1, Activity #2, and Activity #3. Students should begin on the carpet and will then be split into three groups. The groups will not rotate between stations, as it is important for students to begin with activity 1 and progress through activity 3. The class will be split into smaller groups for the benefit of classroom management and role modeling. Students should then reconvene on the carpet for a wrap-up discussion.

Classroom Visit

1. Introduction (15 minutes)

Role Model Introduction:
Being a role model is an important part of being a BASIS volunteer! Begin your lesson by explaining who you are and what you do as a scientist. Feel free to tell your "story" as if giving an elevator pitch to kindergartners: Why did you become a scientist? What questions are you trying to find answers to? What do you do in your job? Why should students relate to you? Feel free to bring in photos, specimens, and other props. Let your personality shine through!

Teaching Tip: What is "science"?

- In a kindergarten class, you may be introducing students to science for the first time!
- Ask students what they know about science.
    - What is science? (Asking questions; finding answers; etc.)
    - What kinds of things do scientists do?
    - Have students ever done any science before? (They probably have, even if they didn't think of it as science!)

Topic Introduction:
After you introduce yourselves as role models, take some time to introduce the topic of this lesson: buoyancy. It may be helpful to keep the suggested take-away in the back of your mind throughout the lesson: **Buoyancy is affected by material, shape, and stability.**

1. Introduce the phenomenon that the class will explore: buoyancy
    - Has anyone ever played in water before? (Pool, bathtub, ocean, bay, lake, etc.)
    - Did you notice anything floating on the water? What? (write on board)
    - Did you notice anything that did NOT float on the water? What sinks? (write on board)
    - What do you notice are similarities and differences between the things that float and the things that sink?
    - Does anyone know why the things that floated did so, and why the things that sank did not float?
    - Today, we're going to be scientists together and try to figure out what makes something float or sink.
    - Introduce the term **buoyancy**: who knows what it means? (write on board, define)
    - To help us think more about buoyancy, so that we are better prepared to do our scientific experiments about it, we're going to read a book together.
2. Read the book Who Sank the Boat? by Pamela Allen.
3. Guide students in a discussion about the book.
    - Who do students think really sank the boat?
    - What did each animal do when they got in the boat? How did this help or make things worse?
    - Introduce vocabulary as it comes up (write on board): **material**, **shape**, **stability**
    - Why do students think the boat sank in the end?
4. Introduce the learning experience
    - We're going to do some scientific experiments to see if we can figure out for sure who sank that boat!

Teaching Tips: Guide Discussion with Kindergarteners

- Be explicit about new vocabulary so that all students can follow along.
- Wait 2-3 seconds before calling on anyone to answer a question.
- Consider using "pair-share" technique to encourage participation: instead of taking answers right away, have students turn to a partner to share first.
- Remind students to be respectful listeners.
    - A "speaking stick" can ensure that only one student speaks at a time.
    - Sandwich negative feedback inside positive feedback: "I'm glad you have so many ideas to share, but right now we're all listening to what someone else has to say. I'd love to hear your thoughts later on!"

2. Learning Experience (45 minutes)

Students should be split into a number of smaller groups for the following three activities. The groups will not rotate between stations, as it is important for students to begin with activity 1 and progress through activity 3. The class will be split into smaller groups for the benefit of classroom management and role modeling: students will be able to interact with volunteers in a more personal way, and volunteers will be able to guide a smaller number of students to do the activities and make use of the materials.

Activity 1: Material and shape matters! (15-20 minutes)

- Present students with a variety of objects and ask them to make **observations** about them. What **materials** (define) are they made out of? Present each object one at a time. Handing one out to each student. Start with the ping pong ball, then the marble, then the bottle cap.
- Ask students to make **predictions** (define) about whether each object will float. Guide students to use **evidence** to explain why they made those predictions (you may prefer to simply ask the students *why* they think the object will sink or float).
- Put the object in the water and guide students to see whether their predictions were correct.
- Guide a discussion about the **patterns** students notice: which kinds of objects floated? Which kinds of objects sank? How are they similar/different? What kinds of materials floated best?
- Take out all the ping pong balls and repeat with the marbles and bottle caps.
- Reinforce the take-away of this activity: **when it comes to buoyancy, material matters!**
- We know that material matters. Do students think that shape matters? Why or why not? Let's figure it out!
- Present students with a ball of clay. Do they predict that the clay will sink or float? Why?
- Drop the clay into the water. What happened?
- Does anyone have any idea what might happen if we made the clay into a different shape? Would it make any difference if we changed the shape of the clay? Why or why not?

- Take one piece of clay and flatten it (very, very thinly) so that it floats on the water. [Avoid having students attempt this as the clay is difficult to work with and students may become frustrated trying to flatten the clay.]
- Guide student to discuss their observations: Does it sink or float? Why do you think that is the case?
    - Depending on student background/understanding, you can explain what is happening to some degree: the tiny pieces of water want to hold up the clay, but the clay needs to be spread out over lots of parts of the water or else it will be too heavy for the tiny pieces!
    - You also can guide students to try out a model on their own: Hold this book in one hand. Is it heavy or light? Now hold it in two hands. Is it harder or easier to hold up? Now hold it in two hands and have a partner hold the other side with two hands. Is it harder or easier to hold up? The water wants to do the same thing, by sharing the weight of the clay among lots of tiny pieces of water!
- Ask students: is our flat piece of clay like a boat? Why or why not?
    - Eg yes, it floats; no, it has no walls and can't hold anything
    - What could we do to make it more like a boat?
    - How about if we add walls?
- Take another ball of clay, mash it flat, and bend the edges up to form walls.
    - Is this more like a boat?
    - This is a **model** of a boat. A model is a smaller, simpler version of something. We can use models to study things that are big or complicated! Eg model airplane, globe.
- Put the model boat in the water (it should float).
    - Does the shape make a difference? Why or why not?
- Reinforce the take-away of this activity: **when it comes to buoyancy, shape matters!**

<u>Activity 2: Building the best boat model</u> (10 minutes)

- Pass out a flattened piece of aluminum foil to each student and present them with the challenge of building the boat that can hold the most pennies.
- What are some things to include in your model? Should it be flat on the bottom? What about walls?
- Have the kids make their own model boats and place them onto the surface of the water.
- Do the coin experiment
    - How many coins do you think this boat can hold? What are your **predictions**?
    - Guide students to load the model boat with coins until it sinks, *counting* how many coins they put in the whole time.
    - How many coins did each boat hold? How does this compare to their predictions? Why did some boats hold more than others? What **patterns** do students see in terms of how many coins the boats held?
- If time allows, invite students to make adjustments to their boats to help them stay afloat better. Guide students to consider what they are changing, and why they think those adjustments might help. You can also start to introduce the concept of stability here – what if

the coins are all placed on only one side of the model boat? Do they distribute the weight? Why or why not?
- Reinforce the take-away of this activity: **when it comes to buoyancy, shape matters!**

Activity 3: Stability matters! (10 minutes)
- We've figured out that material and shape matter. Do you think the order that things are put in a boat matters? Why? Let's figure it out, by thinking about Who Sank the Boat? again!
- Float the aluminum containers inside the bins. This is a **model** for our boat.
- Each station will have several containers of coins prepared. Each container of coins will be labeled with an animal from the book: cow, donkey, pig, sheep, and mouse.
- Place the animals into the boat in the order of the story. Does the mouse sink the boat at the end? (Note: depending on the weight distribution and stability, the mouse may or may not sink the boat. If the boat does NOT sink, use this as a discussion point with students)
- Try it again, this time switching up the order of the animals.
- What happens if the boats are not properly balanced? Does the order of loading matter? Introduce the word **stability** (**stable**).
- If you have extra time, feel free to let the students take turns adding an animal to the boat, thinking about maintaining stability as they go.
- Reinforce the take-away of this activity: **when it comes to buoyancy, stability matters!**

3. Wrap Up: Review and Discuss the Learning Experience (5 minutes)

Review vocabulary words, and go over the important questions. What kinds of things affect buoyancy? What floats well? What doesn't float well? What about the order that the animals get into the boat, and how balanced they make it? Who is really responsible for sinking the boat, and why do we blame the mouse?

4. Connections & Close (5 minutes)

Draw in connections to the real world around students:
Invite students to think back to their own experiences with buoyancy. What floats in the bathtub? On the SF Bay? As a bonus, bring in some photos of huge cargo ships on the Bay, and invite students to think about how those huge heavy ships might be able to stay afloat.

Close:
Ask students if they have any questions about science or being a scientist. Close with a good bye and a thank you, and encourage the kids to keep an eye out for things that float!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

NGSS:

- Connections by topic
  - Physical Science: K. Forces and Interactions: Pushes and Pulls
- Connections by disciplinary core ideas:
  - Physical Science: K-PS2 Motion and Stability: Forces and Interactions
- Connections by scientific & engineering practices
  - 1. Asking questions and defining problems
  - 2. Developing and using models
  - 6. Constructing explanations and designing solutions
- Connections by crosscutting concepts
  - 2. Cause and effect: Mechanism and explanation
  - 7. Stability and change