E d u c a t i o n   a n d   R e s e a r c h :   T e s t i n g   H y p o t h e s e s

Lesson Plan—Hang Ten on an Ice Flow

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Summary

Studying biological and physical processes in harsh or remote environments introduces very unique and unpredictable challenges for researchers. Dr. Victoria Hill runs into some of these obstacles while studying light and temperature in the Arctic as well as the effects caused by warming of the ocean. Students will develop a workable model to recreate and observe the movement of Dr. Hill's research buoys in both the ice and the water in a laboratory setting. Dr. Hill's data showed her buoys moving faster in the ice than in the water following the melting of the ice (figure: https://sites.wp.odu.edu/BORG/current-projects/warm-buoy-maps/). Students will develop their models by experimenting with various materials to represent floating ice in the water while fans or blowers create wind and water currents. They will graph the movements of a model buoy on the "ice" and in the water, and compare their results with Dr. Hill's data, ultimately aiming to determine which materials created the most accurate model. These models could then be used to run simulations for future research plans.

Access to data: https://sites.wp.odu.edu/BORG/current-projects/temperature-and-irradiance-measurements-in-the-arctic/

[TAGS: Marine science, arctic, ice, oceanography, scientific models, scale models, mathematics, creativity, design, engineering.]

Key Concepts

- Marine science, arctic, ice, oceanography, scientific models, scale models, mathematics, creativity, design, engineering, graphing, fluid dynamics
- Next Generation Science Standards Grades 3 to 5
    - 5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution
- 3-ESS2-1 Earth's Systems: Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
- 3-PS2-2 Motion and Stability: Forces and Interactions: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- 5-PS1-3 Matter and Its Interactions: Make observations and measurements to identify materials based on their properties.
- 3-5-ETS1-3 Engineering Design: 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.

Objectives

Include clear, measurable statements of what students will be able to do, such as:

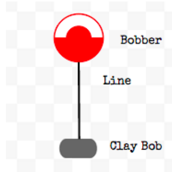
- ***Measure distance in relation to time***
- ***Construct a scale model of wind-driven ocean surface currents***
- ***Communicate results of different model systems***
- ***Compare and contrast properties of materials***

Materials

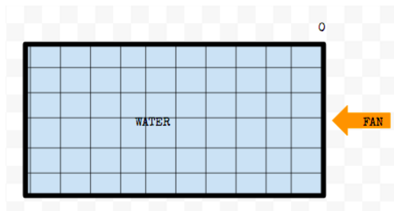
- tape for grid lines
- large, clear, rectangular, watertight tank (shallow preferred, but not required)
- box fan or floor blowers (type meant to dry floors after a flood or large spill)
- tablet or phone with video capability
- hot plate or microwave for heating water
- tape
- glue

- fishing bobbers
- data recording sheets, graph paper best
- clay
- fishing line or thin string
- styrofoam, different thicknesses and densities
- plastic lids, variety
- air dry clay

Procedure



1. Lesson prep-draw or tape grid on the bottom of the large container. Create buoys of proper lengths with bobbers, string, and clay weight on the end. Length is dependent on the depth of the water in the container. Set up fans/blowers at the right side of the container.



2. Begin designing ice floats. Students break into groups, each group will choose a different material and insert their buoy. Ice floats should be scaled to fit in the water container.
3. Groups take their turn deploying their ice floats at grid zero and video results.
4. Replay video and record data, pausing at specific time points, e.g. 1s, 2s, 3s, etc.
5. Graph data. Compare with one of the 4 buoys as found at buoy maps. (link: https://sites.wp.odu.edu/BORG/current-projects/warm-buoy-maps/)
6. Re-engineer ice float. Test again as needed until the experimental results match the real data.

Reflection and Evaluation

- Students share results of different ice float models, including what surprised them.
- **Performance**—During the lesson, students will demonstrate understanding how scientific models aren't perfect models of oceanography. As a reflection, students will share what inferences can be made with the data collected and what inferences should not be made.
- **Product**—During the lesson, students will construct a model of an ice float and demonstrate its ability to predict real world observations.
- Assessment should be directly related to the lesson objectives
    - *Measure distance in relation to time.* Present the distances traveled over a certain period of time, e.g. how far traveled in 10 seconds.

- *Construct a scale model of wind-driven ocean currents*. Successful models will be shared with the entire class.
- *Communicate results of different model systems.* Compare working models between groups.
- *Compare and contrast properties of materials.* Discuss why some models were not successful.

Additional Resources

Websites:

Dr. Victoria Hill's website: https://sites.wp.odu.edu/BORG/current-projects/temperature-and-irradiance-measurements-in-the-arctic/

Life in the Arctic: http://www.thearctic.is/articles/overviews/homeland/enska/index.htm

National Snow and Ice Data Center: https://nsidc.org/

NOAA Ocean Currents: http://www.noaa.gov/resource-collections/ocean-currents

Lesson Extensions

Engineer buoys with different instruments made out of various materials to investigate the effect of buoy design on the model. (Good link: https://www.stevespanglerscience.com/lab/experiments/colorful-convection-currents/)

Create a current by pouring warmed water into far corner of the ocean container. Try adding food coloring to the warmed water to visualize how temperatures mix. Or, if teacher has access to an aquarium bubbler or pump, that can be used to create a current.

For younger learners, add a narrative, such as an animal or person wanting to get to a place faster.