Science Unit: **Water Around Us**

Lesson 4: ***Moving in Water - Resistance, Buoyancy***

School Year:	2015/2016
Developed for:	Aboriginal Focus Elementary School (MacDonald Elementary School in the process of renaming), Vancouver School District
Developed by:	Ingrid Sulston (scientist); Fiona LaPorte and Brenda Koch (teachers)
Grade level:	Presented to grades K and 2-5; appropriate for K-7 with age appropriate modifications
Duration of lesson:	1 hour

Objectives

1. Manipulate shapes in water, to feel the resistance of water against a moving object.
2. Experiment with materials of various density to experience buoyancy in water.
3. Learn how an animal in water is adapted for moving through, and floating in, water.

Background Information

Water resistance is a force that students can experience directly. They are familiar with the push of water as they try and walk or swim through it. They may not have thought about the same force on other animals moving through water, and how their shape affects water resistance against their movement. Streamlined shapes, such as boats, minimize water resistance by diverting the water smoothly around them, and animals that need to move fast through water also have streamlined shapes.

When an object is placed in water, its weight (the force of gravity pulling on its mass) pushes down on the water. The water pushes back up on it, called the force of "buoyancy" (or "upthrust"). The object rests at a level where these forces are balanced. If the object is denser than water (including any air contained within the shape of the object), the force of its weight will be greater than the force of buoyancy and it will sink. Fish can regulate the amount of air in their swim bladder and adjust at what water depth their weight and buoyancy are balanced, therefore maintain a desired depth in the water without expending a lot of energy.

Vocabulary

Water resistance	The force of water pushing back against an object moving through it. Also called drag. (Air resistance is the same phenomenon in air.)
Streamlined	A shape that presents very little resistance to a flow of water (or air) around it.
Buoyancy	The force of water pushing up against an object.

Materials for Water Resistance activity (per pair, or small group of students)

- tray of water
- four small binder clips
- 6 marbles
- fishing line, twice the length of the tray
- modelling clay (two strips from a dollar store pack)
- two little pots with handle (e.g. dollar store shot glasses with masking tape handle)
- two medium binder clips

Materials for Buoyancy activity (per small group of students)

- deep tub of water
- small pieces of styrofoam (2x2x2cm)
- materials to weigh down the styrofoam e.g. nails, paper clips, modelling clay

In the Classroom

Introductory Discussion

For our lesson which focused on fish adaptations in water, we discussed how fish can apparently so easily move through water and swim where they want. Students were told that they will use models to understand better how fish move in water.

For a lesson on water resistance and buoyancy in another context, the introductory discussion should be adapted accordingly.

Brief description of science activities in this lesson:

(1) Water Resistance of Different Shapes: move different shapes through water, to find out how their shape affects their speed.

(2) Buoyancy and Floating in Water: combine materials to float at a specific depth in water.

Processes of science that the students will focus on: exploration, curiosity, mechanical manipulation, close observation, accurate drawing of observations, designing experiments, classifying and comparing data, recording results, inferring, hypothesis testing, concluding, predicting.

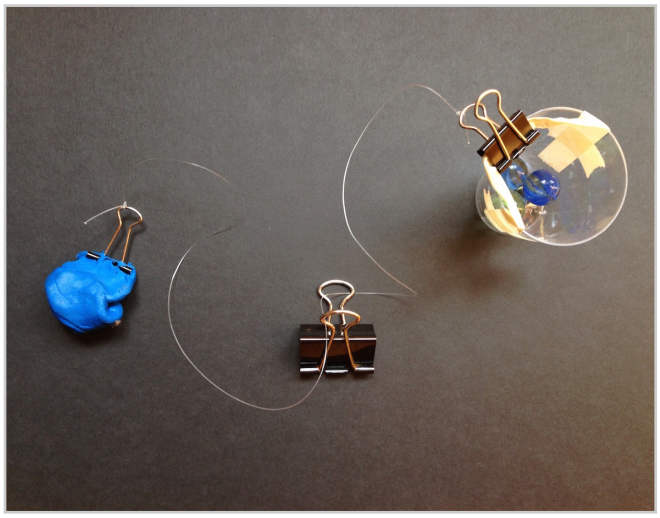
Science Activities

(1) Activity Title:

Water Resistance of Different Shapes

Purpose of Activity:

To understand how and why different shapes move at different speeds through water.



Methods and Instructions:

1. Students will work in ideally pairs, or groups three, maximum four.

2. Set-up prior to experiment:
   Assemble enough fishing line/clay units so that every group has two units. (It will take a while, but pairs of units can be stored for future use in baggies to avoid tangling.)

3. See photo for one unit and follow these instructions for assembly:
   - Cut a piece of fishing line a little longer than the tray.
   - Remove one arm (handle) from a mini binder clip, tie one end of the line to its remaining arm, and wrap modelling clay around the body of the binder clip. (Left photo.)
   - Thread the fishing line through the arms of the medium binder clip, then tie the free end to the other mini binder clip.
   - Attach the handle of a pot to this mini binder clip. (Right photo.) Make two of these for one tray.
   - Half fill the tray with water and place at the edge of a desk.
   - Attach two fishing line/clay units side by side at one end using their medium binder clips.
   - Add three marbles to each pot, and allow the pots to hang down so that their weight pulls the clay against the medium binder clips.

4. Students make two different shapes from the two pieces of clay in the same tray. To find out which can move the fastest through the water, pull them both to the end of the tray and release at the same time.
5. Ask students to use their worksheet to draw the shapes and record which was fastest. Ask them to do three trials to make sure that they are getting reproducible results. It may take more trials if the shapes are of similar speeds.
6. In general, wider shapes move more slowly than narrower, longer "streamlined" shapes.
7. To compare to fish shapes or other animals that move through water: [fish] that can move the fastest (e.g. those that hunt live prey, like salmon) have longer, narrower shapes than those that do not move as fast (e.g. those that eat plants/algae). An image of [fish] silhouettes is useful for comparing animal shapes.
8. To compare to shapes of boats, or other objects that are built to be streamlined and minimize water resistance, use images to discuss the various shapes and jobs of the [boat].

(2) Activity Title: Buoyancy and Floating in Water

Purpose of Activity:

To appreciate how small changes in density can affect buoyancy.

Methods and Instructions:
(This activity inspired by Ref. 1.)

Set-up prior to experiment: Fill large tubs with water.

Students will work in small groups.

1. Give each student a piece of styrofoam. Challenge them to add nails, paper clips and modelling clay to give it neutral buoyancy, so that it floats half way down the tub of water.
2. To actually make the assembly float half way down the water is quite hard, so maybe modify the challenge to make an assembly that sinks as slowly as possible.
3. Discussion in relation to fish: Fish are able to swim at different depths in water - near the surface or deep, so that they can move to find food or hide from predators. They do this by varying amounts of air in their swim bladder. This activity models how fish float at different levels in water. The styrofoam holds air so that it floats (like the fish swim bladder) and the heavy loads pull it down in the water (like the fish body). Just as students balance the styrofoam with the weight of the objects added to achieve neutral buoyancy, fish can balance the amount of air in their swim bladder with their body mass to float at the level they need. This allows them to use their energy for moving back and forth, with no need for energy to stay at a certain depth.
4. Discuss in relation to buoyancy of submarines etc, by comparing their density when air is added/removed from a storage tank, and how this would affect their neutral buoyancy level in water.

References

1. <http://www.cosee.net/best_activities/activity/The_Great_Plankton_Race.pdf> Centers for Ocean Sciences online hands-on science activity.