SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Controlled Buoyancy Submarine — Grade 8 Fluids

Lesson Plan

Cross Curricular	French as a second language
Safety Notes	Have a mop and bucket present to keep the floor dry

Big Ideas
- Fluids are important components of many systems
- Fluids have different properties that determine how they can be used

Overall Expectations
- Investigate the properties of fluids
- Demonstrate an understanding of the properties and uses of fluids

Specific Expectations
2.4 investigate applications of the principles of fluid mechanics
2.7 use appropriate science and technology vocabulary
3.2 describe the relationship between mass, volume, and density as a property of matter
3.5 determine the buoyancy of an objects, given its density, in a variety of liquids
3.8 compare the ways in which fluids are used and controlled in living things to the ways which they are used and controlled in manufactured devices (e.g., compare the role of a fish's swim bladder to the role of the ballast tanks in a submarine)

Description
In this lesson, students will apply their understanding of density and buoyancy to create a submarine. Using a pop bottle, they'll be required to adjust the submarine's buoyancy so that it can both float or sink. This is an inquiry based activity where students are encouraged to apply the engineering design process. Strategies to teach this as an FSL lesson are provided.

Materials
Introduction
- Modelling Clay
- Bucket of water

Action
- 2L pop bottles
- Balloons
- Syringes
- Airline tubing
- Modelling Clay
- Straws and paperclips
- Weights (rocks, beads, coins, etc.)
- Tape, markers, scissors, elastics, etc.

Accommodations/Modifications
- To simplify the activity, provide students with hints or steps to build the submarine
- To expand the activity, get students to build a hook and provide them with a weight they have to lift with their submarine.

FSL Activities
- The Knowledge Assessment Scale
- Concept Chart
- Word Storm

Introduction

FSL Activity: The Knowledge Assessment Scale

The Knowledge Assessment Scale is a vocabulary tool that allows students to evaluate their understanding of words related to the topic, which serves as an ideal starting point for the lesson. Teachers can use this tool to ensure they're focusing on the science topics that need the most work. To complete a Knowledge Assessment Scale, choose ten words related to the topic and have the students indicate if it is a "known word", a "word I've heard" or an "unknown word". To help students build confidence in the unit, ensure a couple well known words are included in the list of words. (Macceca & Brummer, 2010)

Science Activity

Students will complete an inquiry activity in which they compare the buoyancy of a ball of clay and a boat made using the same clay. By following the procedure included on the "Buoyancy Handout", they will be able to investigate density in relation to mass and volume and relate density to buoyancy.

Discuss some of the **key concepts** of density and buoyancy if needed:

- Density is dependent on both mass and volume. The average density of an object equals its total mass divided by its total volume. Increasing the mass or decreasing the volume will increase the density of an object. Decreasing the mass or increasing the volume will decrease the density of an object.
- The density of an object determines whether it will sink or float in another substance. If an object is less dense than the liquid it is placed in, it will float. If it is denser than the liquid it is placed in, it will sink.
- In the introduction activity, changing the shape of the ball into that of a boat changed its volume so that it became less dense than water and floated. By adding water into the boat, the mass was changed so that it became denser than water and sank.
- This can be used to explain how boats float. While boats have a large mass, it is spread across a large volume that reduces its density to below the density of water, allowing it to float.

Action

FSL Activity: Concept Chart

The Concept Chart can be used to enhance a student's understanding of key vocabulary terms. By going beyond the definition in the dictionary, students will have a deeper appreciation for the word. To complete the Concept Chart, have the students choose one vocabulary term from their Knowledge Assessment Scale that they indicated as "word I've heard". Using this vocabulary term, they will be required to fill out the graphic organiser with "what they know",

"what it resembles" and "examples". Once each student has filled in the organizer, they can share it with the class to improve the overall understanding of concepts being learned. To assist FSL learners, this task can be done in partners or you can fill in one of the categories ahead of time to model the activity. (Macceca & Brummer, 2010)

Science Activity

Students will use the engineering design process to build a controlled buoyancy submarine. The '*Build a Submarine'* handout can be used with this portion of the activity. The steps of this process are:

- **Ask:** Identify the problem and the restrictions that you have
- **Imagine:** Brainstorm possible solutions to the problem and choose one to pursue
- **Plan:** Draw a detailed diagram of your solution and identify the materials needed
- **Create:** Build your solution and test it
- **Improve:** Make changes to your solution so that it's even better
- **Repeat:** Identify new challenges and repeat the process

Once students have identified the challenge and come up with a plan which includes a design and material list, allow students to get the material they will need for their model and start building. Encourage them to try different approaches, materials and strategies. The *'Build a Submarine'* handout can be used to guide this activity.

Prepare a large container of water for students to test their model submarine in. Students should have the opportunity to test their design and look for solutions to any issues they may have observed. Once students have completed a working model, give them the chance to come up with a simple presentation for their submarine. Topics that students can include are the name of the submarine, the material they used, how it works and the changes they made while building it. Give each group the chance to present their submarine and then demonstrate how it works in the large container of water.

Discuss the outcome of the activity:

- Density is dependent on mass and volume. To make the submarine float and sink, students will have to find ways to decrease or increase the density of the submarine respectively.
- There are many different ways to accomplish this but the density of the submarine can be reduced by adding air or removing water, depending on how it's built. This will cause it to float.
- Similarly, the density of the submarine can be increased by removing air or adding water. This will cause the submarine to sink.

Consolidation/Extension

FSL Activity: Word Storm

To complete a word storm, use the same words from Knowledge Assessment Scale and scatter them in the box. Students will then use those same words to write complete sentences. This activity will help reinforce students understanding of their vocabulary as they are required to make connections between terms and they will have to take their time piecing them together. Students can complete this task in pairs. To extend the activity, have students add their own words to the word box based on some of the vocabulary they learned in this lesson. (Macceca & Brummer, 2010)

Assessment

Use the "*Build a Submarine*" rubric to assess the science components of this project. The 'Build a Submarine' handout also has students reflect on their project, which can be used in the form of assessment *as* learning.

Teachers can also evaluate French with this same project so long students are informed on what they're being evaluated on. Ensure that the French component is assessed as a French mark and that the science component is assessed as a science mark. Students should not lose science marks for improper use of French or vice-versa.

Additional Resources

The following documents are required for this lesson:

- Buoyancy handout
- Build a Submarine handout
- Build a Submarine rubric

Works Cited

Macceca, S., & Brummer, T. (2010). *Stratégies de lecture en mathématiques, en sciences et en sciences sociales.* Montréal, Québec, Canada: Chenelière éducation.