Innovative Practices in Science and Technology Grades 1-8
and Science Grades 9-12

The Council of Directors of Education (CODE) is conducting a research project called "Science and Innovation in Ontario Schools". A key component of this project is the identification and collection of examples of current innovative practices in science education that impact on student achievement and engagement in science.

Purpose:

- Identify and collect samples of current innovative practices in science education (e.g., integrated models, STEM models, problem based learning, experiential learning) that impact student achievement and engagement
- Share these practices with all Ontario school boards and the Ministry of Education

Procedure:

- Innovative Practice submissions are welcome from all school boards in Ontario
- Please send all submissions to Milan Sanader, member of the CODE Science and Innovation team at milan_sanader@outlook.com
- Collection period: February 1 to April 30, 2017

Type of Innovative Practices to Consider

The practices collected may vary in scope from:

- Classroom (practices of an individual teacher, e.g., innovative lesson or lab activity)
- Department or school (practices of a department or collaborative team, e.g., a unique approach to team teaching, school-school collaborations)
- Board (innovative system-wide initiatives, e.g., Inquiry and STEM training materials)

Selection Criteria

The ideal practices to be included in this collection are:

- Identified as being innovative and engaging by a school board coordinator, instructional leader or equivalent
- Readily adaptable by other boards without a huge investment of time and resources
- Shareable (e.g., all appropriate permissions have been obtained, free of copyright)

Suggested Format

- Title page
  - Name of Innovative Practice
  - Name of Contributor, e.g., teacher name (optional), board name
  - Contact information (optional)
- Introduction
  - One paragraph summary of the practice and its significance
- The Innovative Practice
  - Classroom-ready print or online materials (e.g., student worksheets that have already developed and used by the contributing teacher, existing workshop materials developed by the contributing board)
  - Additional instructions/advice to help others adopt this practice

Samples below:

1. Using Group Demonstrations to Observe and Analyze Wave Characteristics and Behaviour (sample teacher-developed practice)

2. Levels of Inquiry and STEM (sample board-developed practice)

Using Group Demonstrations to Observe and Analyze Wave Characteristics and Behaviour

James Ball

Upper Grand District School Board

Introduction

I have my students act out what I call interactive group demonstrations (IGDs). These can be done in the classroom, in the halls or outside the school. These demonstrations involve all the students playing a role to model a characteristic, behaviour or phenomenon. These can be done in many different areas of science. I have used them in grade nine electricity and grade twelve electricity and magnetism. I also use them in grade ten optics and the sound unit of grade eleven physics. Lastly, I use them in the grade twelve waves and light unit. By no means is this a complete list as I have also used them to model collisions in the Large Hadron Collider (LHC).

As part of the grade eleven sound unit, I use IGDs to model the phenomenon of beats, the Doppler effect and to show basic waves characteristics. The activity that I have included relates to the Doppler effect.

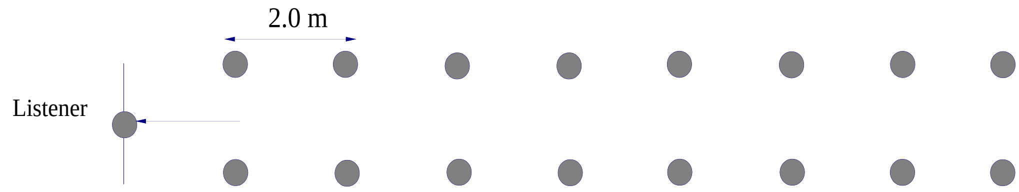
Some of the students act as waves while others observe and record both qualitative and quantitative information about the waves. As this means up to thirty students will be moving around, outdoors is the best place to do the activity but a hallway or gymnasium will also do.

Students love to get up and move around, especially if it's outside on a sunny day. By physically modelling the behaviors, the students gain a much better conceptual understanding of wave behaviour.

(See the sample Doppler activity below)

Activity: Doppler Effect with a Moving Observer

Have the students line up as shown below (top view). The listener will need a stopwatch



1. Have the students line up about 2 m apart. This is done easily if they hold a measuring tape. Each pair of opposing students represents a wave crest.

2. Students (the waves) should practice walking towards the listener at a steady pace.

3. Once they can do so the listener should determine the wave frequency (count the number of waves and measure the amount of time). The wave speed can be found my multiplying the number of waves by 2.0 m and divide by the time. Have the wave crests clap as they pass the student to reinforce the point.

number of waves______ time _____ frequency _____ speed _____

4. They should then repeat this process but have the listener walk towards the waves. You will need to measure the distance the listener walks to determine their speed

number of waves______ time _____ perceived frequency _____ walker speed _____

5. Finally have the listener move in the same direction as the wave but more slowly than the wave. (They should start in front of the wave)

number of waves______ time _____ perceived frequency _____ walker speed _____

Questions

1. Did the actual frequency of the waves change when the observer moved towards or away from the waves?
2. How did the perceived frequency of the waves change when the observer moved towards the waves?
3. How did the perceived frequency of the waves change when the observer moved away from the waves?
4. Under what conditions would the perceived frequency be zero?
5. Use the speed of the walker in parts 4 and 5 and the speed of the wave in part 3 to calculate what the perceived frequency should have been and compare it to the measured values using the equation

$$f_p = f' \frac{v_{wave}}{v_{wave} \pm v}$$

Where do we start?

LEVELS OF INQUIRY AND STEM

INTRODUCTION

STEM (Science, Technology, Engineering and Mathematics) programs for the classroom starts from the Ontario Curriculum. As schools and teachers plan for STEM implementation, it is important to ground the STEM learning experience to the classroom where every student will be provided with opportunities to develop skills that are critical in learning through the STEM process. The inquiry process is at the core of the STEM process and guiding students through this process is important in the design and implementation of the STEM program. It is important to carefully scaffold instructional strategies and classroom norms to support the STEM process for learning. This document summarizes a workshop that can be used to train teachers about the four levels of inquiry and their connection to STEM.

LISA COLE
Science & Technology Program Facilitator (K-12)

Four Types of Inquiry and STEM

Let's explore the different ways we could investigate density.

Confirmation Inquiry

Learn about the relationship between density, mass and volume by doing a laboratory investigation outlined by the teacher.

Task: Determine the density of various materials provided by the teacher.

Procedure:

1. Use the laboratory scale to measure the mass of the object provided.
2. The object provided is a cube. Determine the volume of the object.
3. Use the formula for density below to calculate the density of the object.

$$Density = \frac{mass}{volume}$$

4. Repeat this process for a variety of samples of different dimensions.
5. Take an average of the density values you determined and compare this with the actual density of the material provided by the teacher.

Structured Inquiry

In a structured inquiry, the teacher will still pose the question and/or task with some structure to the procedure. Exploration is more open than the confirmation inquiry method however, guidelines are provided for the student.

Task: Determine the relationship between density, mass and volume.

Procedure:

1. Use the laboratory scale to measure the mass of the object provided.
2. The object provided is a cube. Determine the volume of the object.
3. Repeat this process for a variety of samples provided. Each sample is made up of the same material.
4. What do you observe? Can you determine a relationship between mass and volume?

Guided Inquiry

In a guided inquiry investigation, students would be provided with a question/task with an opportunity for students to develop their own procedure to investigate.

Task: Determine the relationship between density, mass and volume.

Procedure:

Student would devise their own procedure.

Open Inquiry

In an open inquiry task, the student would develop their own question and/or task to investigate. However, this does not mean they get to choose any topic they wish. This must still align with concept of density.

Inspiration:

In order to guide the open inquiry towards density, the teacher may set up a visual inspiration.

1. A tank of water with cans of pop of various sizes and types in the water. The cans will float differently depending on the contents.
2. Raisins in a glass of soda water. The raisins will float and sink repeatedly.

Students will develop their own question from making observations. Students will need to be guided to develop good questions.

Students will they develop their own investigation to test their question.

STEM

In a STEM experience, students will still follow an inquiry process to develop an understanding of the intended concept. However, students will develop their understanding by applying the concept in an engineering design process.

STEM Challenge:
Build a devise that will sink to the bottom of the water tank provided and then float back up to the surface using the materials provided.

Reference:

Banchi, H., & Bell, R. (2008). The Many Levels of Inquiry. *Science and Children*(October), 26-29.
http://static.nsta.org/files/sc0810_26.pdf