Science Unit: ***Concepts in Electricity***

Lesson 1: ***Taking a scientific approach***

Summary:	Students learn about the importance of developing ***mental models*** in science to illustrate processes that are difficult to observe (e.g., too small, too slow, too dangerous, etc.) They work in groups to predict the internal construction of "**mystery tubes**" (a section of PVC pipe and nylon ropes, constructed in advance, instructions included in this lesson) which act as a simple model of a hidden system.
School Year:	2013/2014
Developed for:	Lord Selkirk Elementary School, Vancouver School District
Developed by:	James Day (scientist); Marie-Christine Michel and Karina Houle (teachers)
Grade level:	Presented to grade 6; appropriate for grades 5 – 7 with age appropriate modifications
Duration of lesson:	1 hour and 05 minutes
Notes:	This lesson is a modification of lessons: Introductory Lesson: Thinking Like a Scientist: The Earth Around Us: Air, Water & Soil Unit Lesson 7: The Scientific Method: The Earth Around Us: Air, Water & Soil Unit Lesson 1: Introduction to the Scientist: The Electron: Conductivity & Chemistry Unit This lesson assumes that students have a partially developed understanding of the scientific method and that students have had some experience in taking and recording their observations.

Objectives

Students will be able to:

1. Appreciate scientific thinking and, in particular, the importance of developing (mental) models to test hypotheses, refine theories, and strengthen conceptual understandings.
2. Practice developing and testing a simple mental model of a hidden system.

Background Information

There are many different ways in which scientists investigate natural phenomena and identify processes. These include, but are not limited to: collection of relevant evidence; the use of logical reasoning; and, the application of imagination in devising hypotheses and explanations, in order to make sense of the evidence. More technically, this "use of imagination" is referred to as "modeling." Scientists often use models to illustrate processes that happen too slowly, too quickly, or on too small a scale to observe directly, or are too vast to be changed deliberately, or are potentially dangerous.

Have the students read "The Making of a Scientist" (supplementary material) before the scientist comes to the classroom.

Vocabulary

None for this lesson.

Materials

- 1 science notebook per student
- 6 or so mystery tubes (see activity below for mystery tube construction)
- 12 or so model construction packets (see activity below for packet construction)

In the Classroom

[20 minutes] Introductory Discussion

1. [5 minutes] Begin by asking the following question: What do designing an automobile, creating a recipe for cookies, and developing medication for a particular disease all have in common? (Answer: each requires doing many experiments. Developing expertise, whether from cook to chef or from student to scientist, occurs over time and requires encouragement, guidance, and support.)
2. [5 minutes] Ask students to describe a scientist, perhaps by using only five words. Have a few students share with the class their ideas of what a scientist is/does. Tell students about the wide variety of cultures, languages, appearances, and work environments from which scientists come.
3. [10 minutes] Briefly review the scientific method. Following this procedure essentially means thinking like a scientist. This is the best method people know about for understanding the real and objective world around them. This kind of thinking is not always easy, but does become more natural with practice. Using the scientific method includes many (or all) of the following steps.
   (a) Problem: A question to be answered.
   (b) Research: Information gathered about the problem. (Define variables.)
   (c) Hypothesis: A possible explanation or answer.
   (d) Experiment: A test to check the hypothesis.
   (e) Observation: Information gathered through the senses and recorded as data.
   (f) Summary: Concise representation of your data.
   (g) Conclusion: A possible answer to the problem based on evidence from the experiment.
4. Briefly describe the upcoming activity: Mystery Tubes. This activity serves as a nice introduction to the nature of scientific inquiry. Students are asked to determine what the interior construction of a mystery tube looks like. Then, students pose explanations (hypotheses) for what they are observing and are asked to test their hypotheses.

[35 minutes] Science Activity

Activity: Mystery Tubes

Purpose of Activity: To experience the process of science first-hand; to use a constructed model to test a hypothesis.

Experimental Observations: Students will observe the effects of pulling on one or more of four ropes of a mystery tube. The purpose of this experimentation is to determine how the ropes are connected inside the tube.

Prediction or Hypothesis: Support the students in making their hypotheses. They might benefit from being asked a specific question, like “what do you think will happen when you pull on these two ropes at the same time?” or something along those lines. Students should record their

predictions/hypotheses in their science notebooks; these predictions could be in the form of a sketch.

Methods and Instructions:

Set-up prior to experiment: Create six, or so, mystery tubes (distinct or not), an example of which is shown in Figure 1. For best results, make sure that the two pieces of ropes are of slightly different lengths. It is best to burn the ends of the rope to prevent the knots from coming loose. To cap the ends, use non-transparent tape, so that you can replace worn parts over time.

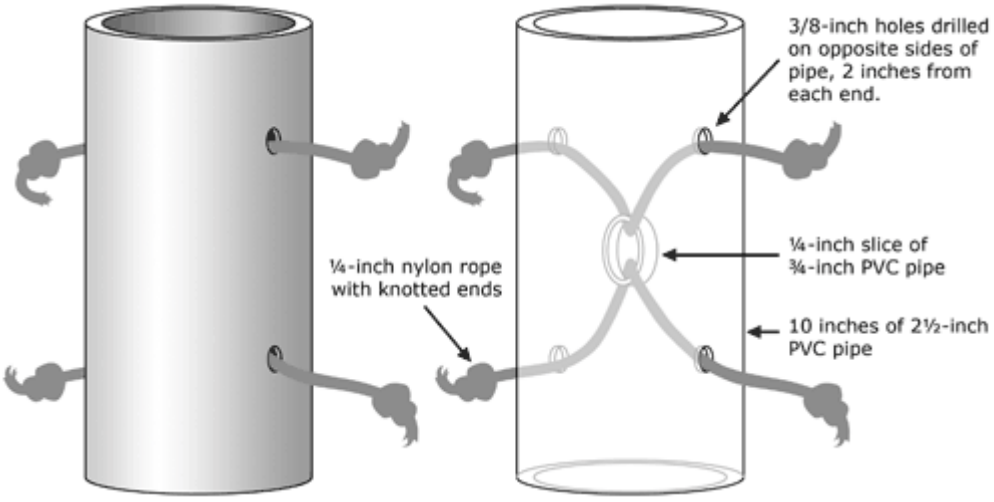

Figure 1: An example of the inside of a mystery tube.

Students will explore mystery tubes in small groups. Each group will be given a mystery tube to explore. As a team, they will develop mental models of the interior construction of their mystery tube and, finally, a physical model of their mystery tube to test their hypothesis.

1. Provide a mystery tube to each group of students, along with their science notebook for drawing diagrams, taking notes, and writing conclusions. Explain to them that their goal is to determine what the interior construction of the tube looks like. Remind them that they cannot open the tube to look inside.
2. [10 minutes] Allow sufficient time for groups to work with the mystery tubes. Provide paper on which students can draw all of their ideas as to what the interior of the tube looks like. Walk around and encourage students to test their ideas and ask how they might do so.
3. [10 minutes] Once all students feel that they have a “solution,” have each group share their findings with the rest of the class. You may have them post their drawings for others to view. This can lead to a form of "peer review" in which students can ask questions of each other.
4. [15 minutes] Ask students how confident they are that their solution is correct. You may ask them to hold up five fingers for very confident, one finger for not so sure. Ask them what they might do to further test their ideas and to increase that level of confidence. Hopefully someone will suggest making a model. This is where the toilet paper rolls come in handy. Hand out a "packet for building a model" to each group of students (these should contain a variety of items that they might use to build a model: scissors, paper punch, buttons, string, beads, rings, paper clips and also an empty toilet paper roll handed out separately). Allow sufficient time for students to build their models and to see if they behave the same way that the Mystery Tube does.

5. [time permitting] Have students share their models and discuss their effectiveness and how those models either support or refuted their original ideas. Discuss other areas of science in which models are used in a similar way — e.g., the structure of an atom.

[10 minutes] Closure Discussion

1. [5 minutes] Have students reflect on what they were doing that scientists do. This could be prompted by the question: "Were you doing science?" Discussion should reflect the concepts listed above.
2. [5 minutes] Ask students how what they were doing is *not* like science. This will be more difficult for them, but eventually discussion should reveal that in this activity they actually could look inside and *know* if their answer is correct. In science, we never know if we really have the correct answer
3. Collect the tubes. *Do not reveal how the ropes are actually connected!*

References

4. Richard Feynman - “The Making of a Scientist” Originally published in *Cricket* Magazine, October 1995 (Vol. 23, #2).
5. http://undsci.berkeley.edu/lessons/mystery_tubes.html.

Extension of Lesson Plan

1. Go to the www.scienceheroes.com website and read some of the biographies of the scientists listed. Choose one of the scientists to do further research about. By reading about historical figures in science and how they conducted their scientific experiments, teachers can help their students to see how scientific knowledge develops. If students have opportunities to study various scientists, it can increase their interest in science and encourage them to think more like scientists. After being introduced to historical accounts of scientific work, students come to appreciate how scientists make amazing discoveries often using simple tools and with great personal sacrifice. Students should come to value skepticism and questioning in open communication. They will see that it is normal for scientists to often disagree with each other and the evidence collected. When results differ they often repeat an experiment and collect new data. Scientists use experimentation as the primary means for collecting data and comparing results. It is also important that experiments are able to be replicated by others.