Science Unit: ***Plastics***

Lesson 2: ***Introduction to the Scientific Method – Part 1***

School year:	2008/2009
Developed for:	Tyee Elementary School, Vancouver School District
Developed by:	Linda Hanson (scientist), Debbie Adams and Sharon Ghuman (teachers)
Grade level:	Presented to grades 4, 5, & 6; appropriate for grades 3 – 7 with age appropriate modifications.
Duration of lesson:	1 hour and 15 minutes
Notes:	The scientist will use an example experiment to demonstrate various components of the Scientific Method. The example used for this lesson is detailed in the "Introductory Discussion" section.

Objectives

1. To introduce students to the Scientific Method.
2. To have students discover the challenges involved in obtaining measurements and observations and discuss methods of ensuring results are repeatable by others.

Background Information

The Scientific Method is an investigative approach in which a problem or question of interest is methodically investigated. The investigator first formulates a testable hypothesis or hypotheses and then must design an unbiased experiment to test each hypothesis. The experiment should be based on objective, unbiased observations and be repeatable.

Vocabulary

Hypothesis:	An educated prediction of what you think will happen.
Qualitative observation:	A qualitative observation is a non-numerical, subjective observation or measurement. For example, a box of coins is **heavier** than a box of feathers.
Quantitative observation:	A quantitative observation is a numerical, objective observation or measurement. For example, this box of coins weighs 235 grams more than this box of feathers.

Materials

- Paint chips of various (similar) shades of blue (1 per student)
- Jar of marbles (or small rocks)
- pennies (1 per student)
- rulers or measuring tapes
- 6-8 plastic fish 6-12" in length (see set up information)
- Two graduated cylinders (one narrow, one wide)
- scale(s)
- small bowl for counting marbles
- 4 graduated cylinders: 1 narrow, 1 wide and 2 of equal volumes but slightly different diameters
- water
- paper to make sleeves for graduated cylinders
- worksheets

In the Classroom

Introductory Discussion

1. Start off with a quick brainstorming session (record ideas on a board or flipchart).
    - What is science?
    - What do you think scientists do? How? Why?
    - Do you do science? Think about your everyday activities.
2. Introduction to the Scientific Method
    - Introduce the concept of the scientific method and thinking like a scientist. Have the teacher write each step on the board/flipchart so that students can refer to it later. Depending on the students' age have them record each step in their notebooks, or distribute a handout after the discussion.
    - As each step is introduced use the demonstration experiment to provide an example. Each step will be discussed (using questions, student ideas or brainstorming). Some steps will have short activities that the students can do at their desks as part of the discussion.
    - Demonstration Experiment: Comparing the decomposition rates of organic material (leaf, carrot) and "biodegradable" plastic (plastic bag, corn-based plastic cutlery). Each item will be buried in a separate container of soil and the change in mass/size will be evaluated on a regular basis. Two types of organic material will be used and two types of plastic will be used.

The steps of the Scientific Method:

Have a question – What are you interested in studying or want to learn more about?

- How does biodegradable plastic breakdown? Are the claims of the manufacturers that it breaks down as quickly as organic material true? What conditions are necessary for it to breakdown? (Have students suggest questions as well)
- Pick one question to look at: Does biodegradable plastic breakdown as fast as organic material? (See example experiment discussed above.)

Do background research – need information and facts on which to base your ideas and experiments.

- Information provided on the biodegradable plastic bag
- Information available from the manufacturer(s)
- Pre-existing knowledge regarding conditions required for decomposition
- Knowledge of conditions present in a landfill

Pick a test factor – what part are you interested in testing?

- The test factor is the only component of the experiment that can vary between treatments. Everything else must remain the same.
- Factor = item to be decomposed

Formulate a hypothesis – What do you think will happen?

- Make a prediction (have the students suggest their predictions)
- I think the plastic will breakdown before the organic material OR I think the plastic will break down after the organic material OR I think that they will breakdown at the same speed.
- Why?

Perform an experiment to test your hypothesis

- Only vary one factor (the test factor) - Must determine and record all other parameters. Have the students suggest what else must be taken into consideration (temperature, soil volume, container conditions, water, air, light level, physical handling of the material, etc.)
- How will you do the experiment? Discuss experimental designs and limitations.
- How will you gather results? Have the students suggest methods (measurements of size and weight taken regularly). What measurements/observations will you take? (dimensions of the leaf and plastic bag and weight of the carrot and plastic cutlery)
- Use the color choice demonstration to distinguish between qualitative and quantitative measurements.
    - Hand out a single, unlabelled paint chip to each student and have them independently decide upon and record the color of their sample (have a total of 5-6 different colors to ensure many students receive samples of the same color). Compare answers as a class. The students will discover that many of them either used the same name for dissimilar colors or used different names for the same color. This type of observation is a qualitative measurement. Discuss the problems associated with qualitative measurements. Discuss the difference between qualitative and quantitative measurements. Use height as an example and use students to demonstrate the example as you explain it. Show how we can use a standardized color card to turn color into a quantitative measurement.

Record your observations

- How will you record your observations? (Brush dirt from each item with a brush and then weigh or measure the dimensions. The dimensions can be measured with a grid or comparisons can be made to a traced outline.)
- Discuss recording other variables, making visual observations, recording everything in their notebooks.
- Stress the importance of accurate observations and measurements (this will be reinforced in the activities to follow and lesson 3).

Perform replicates of your experiment

- Reasons to repeat the experiment: the first result may be due to chance, there are differences between test items, especially if you are using living organisms, make your results stronger and more applicable.
- Coin toss demo: Have each student do this at their desks (1-2 minute activity)
    - Give each student a penny. Ask them how many heads they think they would get if they tossed the coin 10 times. Will they always get the same answer? Have the students toss their coins 10 times and record the class answers. Point out rare

results (i.e. if one student gets 9 or 10 heads) and discuss as a class how they can be misleading if experiments are not repeated.

Summarize your observations

- Discuss averages, ranges etc.
- Briefly discuss ways of summarizing their observations: counts, graphs, tables, pictures etc.

Make conclusions

- Do your results fit with your prediction? Why or why not?
- What do your results mean?
- How applicable are they? Do they apply to every situation? (For the demonstration experiment the results may differ in other soil types, with different amounts of water, in light etc.)
- What would you do differently next time?
- What additional experiments could you do to expand your knowledge of the subject/problem?

3. Briefly describe science experiment/activity.

   Measurement and Observation activities: There will be three different stations. The students will have up to 10 minutes at each station to complete a short activity and fill in their answers on a worksheet. Each station will have its own set of instructions included on the worksheet. (See more detailed information on the worksheets).

4. Briefly describe safety guidelines.

   - Discuss the proper use of the scales before commencing the activities.

Science Activity/Experiment

Activity Title: Measurement and Observation

Purpose of Activity: To introduce students to some of the issues that must be taken into consideration when designing and carrying out the observation and measurement portion of an experiment.

Methods and Instructions:

Set-up prior to experiment:

- Station 1: Cut the tail fins of the fish such that two fish are of equal fork length (but different tail length) and one is of a larger or smaller fork length. The fork length is the distance from the tip of the nose to the fork of the tail. There will be two sets of 3-4 fish.
- Station 3: create removable paper sleeves for each graduated cylinder so that students can see the water level but not the measurement markings.

Have students work in groups of 4-5. There should be 6 groups in total.

1. There will be 3 different stations but each station will be set up in duplicate so that two groups can work on it at the same time. Students will rotate through the three stations.
2. Station 1: How big is it?
    a. Objective: To have students understand that scientists must follow rules to make measurements.
    b. Materials: 3-4 plastic fish (*refer to “set-up prior to experiment” for more information on the fish), rulers or measuring tapes.
3. Station 2: How should we measure it?
    a. Objective: To have students understand that there are different ways of arriving at an answer and reinforce the idea of consistency in order to have them understand the importance of repeatable, accurate measurements.
    b. Materials: A jar of marbles (or small rocks); two graduated measuring cylinders of different diameters (one very narrow and one wide); scale (if available); a dish that the students can pour the marbles out into if they would like to count them.
4. Station 3: How much water is there?
    a. Objective: To introduce the concept of accurate, quantitative (and thus repeatable) measurement.
    b. Two graduated cylinders (different diameters) with equal volumes of water. Have the measurements covered to begin with.
5. Students will record all of their observations on worksheets.

Closure Discussion

1. Students will return to their desks and we will discuss the activities and their implications as a class. We will revisit any thoughts/questions they have regarding experimental design and discuss ideas for other experiments.
2. Hold up the two fish with equal fork lengths but dissimilar tail lengths (i.e. different overall lengths). Ask students if they are the same size. Discuss how some scientists use fork length and other use overall length. How will this impact the results if scientists are interested in body size? Swimming ability? Or other factors.
3. Discuss the problems associated with measuring volumes of marbles in a narrow versus wide cylinder. Did they arrive at the same volume? What if they used this method for rocks or wood chips? Does an equal volume mean an equal weight? Which property is more important? (Will depend on the purpose of the study)
4. How did they measure the water volumes? Discuss the idea of a meniscus.

Extension of Lesson Plan

1. Students can design their own decomposition experiments in small groups. They should record their ideas for each step of the scientific method.

Name:_____

Station #1 - How Big is it?

How big is each fish? Determine an answer on your own and record your measurements below.

Fish #	Size
1	
2	
3	

Discuss your results with each other. Does everyone have the same answer? Discuss with each other how you made your decisions.

Questions I have:

Name:_____

Station #2 - How Should We Measure it?

Work on this activity on your own.

How much is in the jar? Are there different ways you can measure this? Will you get the same answer each way?

Determine some answers on your own and record them below.

Method of Measurement	Amount

Discuss your measurement methods with each other. Discuss how you made your decisions. What did you learn?

Questions I have:

Name:_____

Station #3 - How Much Water is There?

Keep the cylinder measurements covered for now. Exactly how much water is in each cylinder? Do you think they have the same amount of water?

Record an answer on your own.

	Answer with measurements covered	Answer using cylinder measurements
Cylinder #1		
Cylinder #2		

Remove the cylinder covers and record the measurements in the table above. Replace the cylinder covers for the next group.

Were you surprised by anything? Discuss your results and how you made your decisions with each other.

Questions I have: