New Earth Classroom

ACTIVITY 5
Using the Scientific Method to Analyze WATER RETENTION IN SOIL COMPONENTS

LEARNING OBJECTIVES

1. Students will use the scientific method to analyze which material in soil (sand, compost or clay) absorbs the most water.
2. Students will propose a hypothesis to address the question based on the appearance and feel of each soil component.
3. Students will conduct an experiment using specialized laboratory equipment (ring stands, Buchner funnels, and graduated cylinders) to collect data.
4. Students will measure amounts of water in milliliters in graduated cylinders.
5. Students will calculate how many milliliters of water was retained by each soil material.
6. Students will graph data showing how many milliliters of water was retained (absorbed) by each soil material.
7. Students will analyze and discuss the data to draw a conclusion about which material (or what combination of materials) in soil may make the best growing medium for plants.

KEY WORDS

scientific method, hypothesis, experiment, Buchner funnel, graduated cylinder, milliliter, procedure, sand, compost, clay, data, conclusion

EQUIPMENT

- 3 ring stands with clamps
- 3 Buchner funnels
- 3 coffee filters cut to fit on the inside bottom of the Buchner funnels
- 3 squeeze bottles, pipettes, or droppers
- water
- 3 100 mL graduated cylinders
- 3 50 mL graduated cylinders
- 30 grams each of sand, compost & clay
- 1-2 cups of each material (sand, compost & clay) for students to handle and analyze
- Signs on index cards to label stations: SAND, COMPOST, CLAY
- Bar graph (laminated poster or on the board) with material (sand, compost, clay) on the bottom axis and mLs of water absorbed by each on the vertical axis

SUMMARY

For this lab, the class will divide into three groups. Each group will perform an experiment to analyze one of three components of soil: sand, compost, or clay. Each group will have a lab station with their own set of equipment so the three groups can perform their experiments simultaneously.

Each lab station consists of: a sturdy table, a ring stand with a clamp holding a Buchner funnel, a coffee filter cut to fit perfectly on the inside bottom of the funnel, a squeeze bottle, pipette, or dropper, a water source, a 100 mL graduated cylinder, a 50 mL graduated cylinder (put beneath the Buchner funnel, to catch the water that drains), 30 grams of material (sand, compost, or clay), and a sign to indicate the type of material being analyzed at that station (sand, compost, or clay).

BACKGROUND INFORMATION

I. I. BACKGROUND INFORMATION:

A. What is soil?
Soil is a mixture of minerals (bits of rock), living things (microorganisms), organic matter, water and air

B. Living components of soil

1. Healthy soil contains fungi, bacteria, insects, nematodes, protozoa
2. Healthy soil also contains water, oxygen, and organic matter (living or once-living plant or animal material) to feed and support life in the soil

C. Non-living components of soil

1. Sand, silt and clay (bits of broken-down rocks) make up soil structure
2. Soil structure is important because soil holds water and nutrients, allows air flow, and is habitat for microorganisms that help feed plants.

D. Why is it important for soil to hold water?

1. Water supports life in the soil (fungi, bacteria, insects and plants)
2. What happens if there is not enough water in the soil?
(living things in the soil won't be able to survive)
3. What happens if there is too much water in the soil?
(there is less room for oxygen in the soil and therefore fewer living things)

E. Today, we will do an experiment to compare how much water is retained (absorbed) by different components of soil (sand, compost, and clay).

SCIENTIFIC METHOD

II. Explain or review the **scientific method** and how we will be applying that to our experiment today.

A. We begin with a question:
Which material holds the most water: sand, compost, or clay?
Which holds the least?

B. We will make a **hypothesis** (an educated guess). Scientists do research before they try to answer questions. We will also do a short investigation to try to answer this question before we perform the actual experiment.

C. We will then do an **experiment** to test our hypothesis and answer our question.

D. We will use special laboratory equipment so our measurements can be as accurate as possible

LABORATORY EQUIPMENT

1. **Buchner funnel:**
Each soil component (sand, compost, clay) will be in a Buchner funnel, and we will pour water into the funnel and see how much water the sand, compost, or clay absorbs by measuring how much water comes out the bottom. The Buchner funnel is special due to its wide width, so it allows us to pour a lot of water in at once, and then we can wait for it to drain. The Buchner funnel is held by a clamp on a special ring stand, and Buchner funnels are usually made of porcelain so they can be used in many different types of experiments.

2. **Graduated cylinders:**
These are used to measure the volume of liquids. Because they are tall and slender, they measure small amounts of liquids very accurately. We will be measuring water in **milliliters**, which is one thousandth of a liter. Soda often comes in 2-liter bottles. We're measuring in units of one thousandth of half of one of those bottles!

EXPLAIN THE PROCEDURE

E. Explain the **procedure**

1. The class will be divided into three equal groups. One group will conduct the experiment for sand, one for compost, and one for clay.
2. There are several procedural steps, so be sure to take turns doing them so all students get to participate.
3. The first steps require specific instructions, so listen carefully:
   a. Fill your 100 mL graduated cylinder with 50 mLs of water. To make the measurement exact, add water to the cylinder but do not exceed 50 mLs. Use your squeeze bottle, pipette, or dropper to make exactly 50 mLs.
   b. Put the coffee filter in the bottom of the Buchner funnel. Using the squeeze bottle, pipette or dropper, wet the coffee filter (one drop or small squeeze at a time) to form a vacuum seal between the filter and the funnel. This ensures that no material (only water) can get through the funnel.

4. Add the (pre-measured) 30 grams of material to the Buchner funnel. Tamp lightly with your fingers to make sure it's level, but don't pack it in.
5. Make sure the 50 mL graduated cylinder is positioned directly under the Buchner funnel so it will collect the water that drains from the funnel.
6. <u>Have all three groups do this step at the same time:</u> Slowly pour the water from the 100 mL graduated cylinder into the funnel.
7. Once all groups have poured their water, wait as a class for about 10 minutes, when drips from the funnel become less frequent.
8. At the same time, each group will measure the amount of water that drained into the 50 mL graduated cylinder and subtract that number from 50. That will be the amount of water absorbed by your material.

F. Graphing the data:
Data is information collected during an experiment or research. It used to analyze a problem or question to draw a conclusion. One at a time, a representative from each group will come to the board and put their results on a bar graph by shading the number of mLs of water that were absorbed by the material they studied.

G. **Conclusion:** we will analyze the data and discuss the results of the experiment to conclude (decide) what might be the best type(s) of soil for growing plants.

DO THE EXPERIMENT

III. Do the experiment

A. Question: Which material holds the most water: sand, compost or clay? Which holds the least?

HYPOTHESIS

B. Hypothesis:

1. Each group gets a container of 1-2 cups of either sand, compost, or clay. Use your senses (sight, smell, touch) to study the material. Discuss its properties and how these characteristics may or may not enable it to hold water. Do this for about 1 minute, then pass the components to another group for analysis. Continue until all three groups have analyzed each material.
2. Ask each group to rate the materials in terms of which they think will hold the most water, second most, and the least amount of water. Write their hypotheses on the board. If they feel unsure, explain that a hypothesis is a guess, and if we already knew the answer for certain, we wouldn't have to do the experiment!

EXPERIMENT

C. Experiment

1. Measure 50 mLs of water in the 100 mL graduated cylinder. (see instructions above under “II. E. 3. a.”)
2. Put the coffee filter in the Buchner funnel and wet lightly (instructions above under “II. E. 3. b.”).
3. Add 30 grams of material to the funnel and level with fingers, but do not pack.
4. At the same time, each group will slowly add the 50 mLs of water to the funnel.
   The whole class will wait about 10 minutes. During this time, students can walk around and look at what is happening at the three lab stations.
5. Measure the amount of water in the 50 mL graduated cylinder below the funnel. Subtract that number from 50 to figure out how many mLs of water were retained (absorbed) by the soil component.

DATA

D. Data: Each group records their data on a class bar graph

CONCLUSION

E. Conclusion: Discuss as a class

1. Which material absorbed the most water? The least?
2. Were your hypotheses correct?
3. Describe the material that absorbed the most water. What makes it able to do so? What are its properties?
4. In which materials might plants grow best?
5. Sand, compost, and clay can all be beneficial in soil. Sand provides good drainage, clay holds moisture, and compost provides organic material.

   After doing this experiment and learning about which soil component holds moisture best, in what proportions do you think we could combine the components to make soil in which plants could grow well?