Exploring Soils

Overview
Students will investigate soils and learn about soil texture, soil water-holding capacity, and other properties of soils.

Suggested Grade Level
9 - 12

Estimated Time
90 minutes

Objectives
Students will be able to:

1. develop an understanding of how water flows through soils and how the water changes as it goes through.
2. utilize the scientific method; ie, ask questions, develop and test hypotheses, observe and analyze results, and draw conclusions.
3. work together in small groups and share findings with classmates.
4. analyze a soil to determine its texture.

Activity A – Soil Texture

Materials
(per group of 3-4 students)

1. "Soil Texture" Activity Sheet A
2. Soil samples: bring to class 1L samples of different types of soil from around the school grounds or from students' homes. Possibilities include topsoil, potting soil, sand, soils that are compacted, soils with grass growing on top, soils with clearly different textures.
3. 1 quart-jar (mason) with lid
4. Water
5. Marking pen
6. White poster board

Background

Soils are precious natural resources that affect every part of the ecosystem. Soils hold water and nutrients for plants and ultimately animals. All the food we eat and the natural materials we use, such as paper, wood and clothing, depend on soils. It is important to understand soil and its role in the ecosystem and in agriculture.

The physical properties of soils affect the type and amount of vegetation that can grow in a given location. For example, the amount of water a soil can hold (water holding capacity) is a factor affecting the plants that can survive. Certain plants grow in sandy well-drained desert soils while others grow in heavy clay soil wetlands. Soil temperature, soil pH, soil structure, organic matter content, soil moisture and soil fertility are all variables that affect the organisms that can live in the soil, and which, in turn, impact the entire ecosystem.

Soil texture is the way a soil feels, and refers to the amount of sand, silt and clay particles that are present in a soil. Sand, silt and clay particles are all different sizes. The largest soil particle is sand (2.00-0.05mm in diameter), which feels gritty to the touch. The next smaller particle size is silt (0.05-0.02mm in diameter), which feels smooth or "floury" to the touch. The smallest particle size is clay (<0.02mm), which feels sticky and is hard to squeeze in your hand. Most soils have a mixture of sand, silt, and clay. (See Soil Texture Activity Sheet.)

Activity

1. Each group of 3-4 students should have a soil sample.
2. Have students do the "Soil Texture" activity to determine the texture of their soil.
3. Compare results among all of the different groups, and discuss how soil texture affects the uses of soil.

Activity B – Just Passing Through

Materials

(per group of 3-4 students)

1. "Just Passing Through" Activity Sheet B
2. Clear 2L (soda) bottle
3. Three 500mL beakers or similar size clear containers marked off in cm to pour and catch water
4. Soil samples: bring to class 1L samples of different types of soil from around the school grounds or from students' homes. Possibilities include topsoil, potting soil, sand, soils that are compacted, soils with grass growing on top, soils with clearly different textures

5. Fine window screen or other fine mesh that does not absorb or react with water (1mm or less mesh size)
6. Quantity of clean sand
7. Water
8. Clock or timer
9. Red and black marking pens
10. pH Test Kit (Extension option)

NOTE: Smaller containers may be used, if desired, as long as the soil container sits firmly on the water-catching container. Reduce the amounts of soil and water, but have all students begin with the same amounts.

Background

What happens to water when it passes through soil depends on many things such as the size of soil particles (texture and particle size distribution), how the particles are arranged (structure), how tightly they are packed (bulk density), and the chemical attraction between the soil particles and the water. Some types of soil let water flow in quickly, and then hold the water inside the soil like a sponge. This might give plants a better chance of using some of that water. Other types of soil may let the water go completely through in just seconds. Still other soils may keep water from getting in at all. None of these soil types is better than the other; they are simply different.

Activity

1. Hand out "Just Passing Through" Activity Sheet B
2. Remove label and lid and cut off bottom (above curve) of the 2L bottle.
3. Turn the bottle over so it looks like a funnel and place a circle of screen inside the bottle so that it covers the cap opening.
4. Pour 3-4 cm of sand onto the screen. The sand will keep the screen from becoming clogged.
5. Place the bottle, mesh side down, on a beaker or clear container.
6. Pour 1L of soil into the bottle over the sand.
7. Conduct the Class Demonstration and Inquiry.
8. Have students do the Group Investigation.

Class Demonstration and Inquiry

1. Choose a soil for the classroom demonstration (a sandy loam works best) and put some of the soil out on white paper on a table for students to observe. Have students look closely at the soil and notice the color, presence of plant material or other organic matter, the feel, the shape of the particles and record their observations of the soil on the board.

2. Next, place a 1L soil sample in the cut off 2L bottle inverted over the beaker. Pour 300mL of water into a 500mL beaker or other clear container and mark the level in black. Have students notice the clarity of the water. Ask students

what will happen when we pour the water into the soil. Ask follow-up questions that get students to explain why they think the soil and water will behave as they predict. Possible questions may include: Will the water run through the bottom of the bottle? Will it all run out? If not all, how much? What will the water look like? Clear? Murky? Very dirty? How long will it take for the water to flow through? Record all the student hypotheses on the board. Mark the pouring container with a red line where the students predict how much water will flow through the soil.

3. Pour the water onto the soil and begin timing. Ask students to describe what happens as you pour the water. Is the water staying on top? Where is it going? Do you see air bubbles? Why or why not? Does the water coming out of the soil look the same as the water going in? Record the class observations on the board. Also record the time it took for the water to go through the soil.

4. Ask students to compare their hypotheses with what they observed. Once the water has stopped dripping from the bottom of the bottle, remove the soda bottle and hold up the beaker of water that passed through the soil. Ask students to compare their hypotheses about the water to their observations. Pour the water back into the pouring container and compare the amount with the starting amount (black line). How much water is missing? How can we measure the missing amount? Compare the amount of water with the amount students predicted would come through the soil (red line). Is there more or less water then the class predicted? What happened to the missing water? Is the water more or less clear than the water that was poured through the soil? Compare samples.

5. Have students predict what will happen if they poured more water into the soil. Record their hypotheses and try it. Compare the observations with their predictions and ask clarifying questions. Next, have students try the same investigation with other soil samples**. NOTE**: Wash funnel and screen and add more clean sand before using a new soil sample.

Group Investigations

1. Give each student the "Just Passing Through" Activity Sheet, which is a place to record hypotheses, observations, and conclusions. Have the students, in groups of 3-4, repeat the above investigation with the other soil samples.

2. Have students share their results and conclusions with the whole class. Discuss why there were differences between soil samples. Have students draw conclusions about water holding capacity based on the properties of soils.

3. Compare the results of the group investigations. Discuss the differences in soils. Ask questions about soil properties and uses of soils. Which soil property would you look for if you wanted to plant a garden? …build a driveway or a playground? What would happen if the soil is full of water and a heavy rain falls on it? How can you change the way your soil holds water? What happens to the soil when organic matter is added, when plants are growing on top of it, when it is compacted, or when it is plowed?

Extensions

1. Have students try this activity with soil components such as pure sand or clay and compare the differences. They could also do the activity with other materials such as commercial potting soil, perlite, compost, and vermiculite and make conclusions about the properties of these soil enhancements.

2. Students can experiment with filtering by using very murky water and passing it through clean sand.

3. Using distilled water, have students measure the pH of the water. Predict whether the pH will be different after the water passes through the soil. Pour the water through, and then test the pH again. Have students draw conclusions about the affect of soil on water pH.

Adapted from the GLOBE Program, Global Learning and Observing to Benefit the Environment.

Name _____ Activity Sheet A

Soil Texture

Soil Texture by Feel

Human hands are sensitive to differences in soil particles, so one way of determining the texture of a soil is by "feel." The largest soil particle is sand (2.00-0.05mm in diameter), which feels gritty to the touch. The next smaller particle size is silt (0.05-0.02mm in diameter), which feels smooth or "floury" to the touch. The smallest particle size is clay (<0.02mm), which feels sticky and is hard to squeeze in your hand. Most soils have a mixture of sand, silt, and clay.

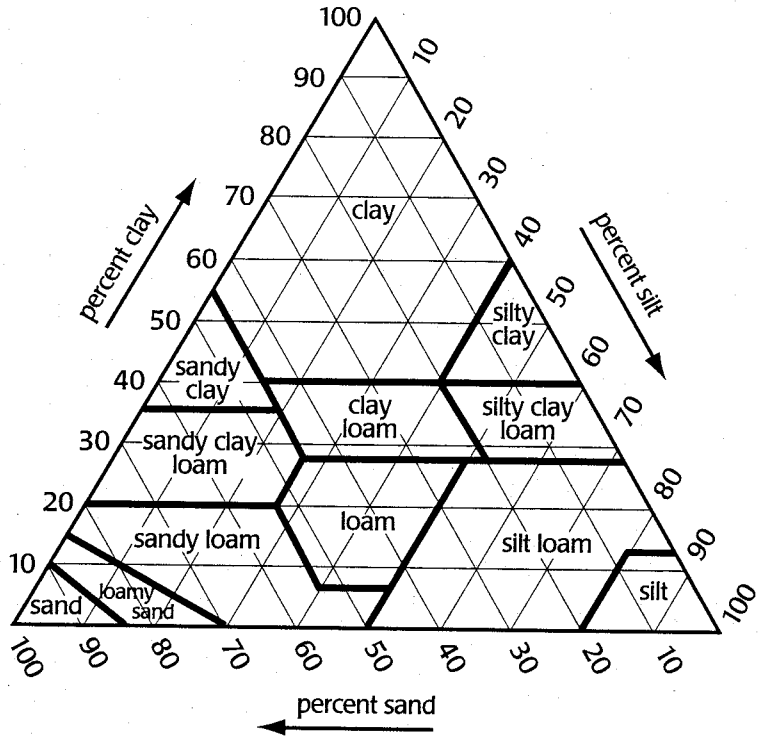
One way to determine the texture of a soil is by moistening a soil sample and trying to form the ribbon with the sample. By feeling the soil sample and answering questions about its behavior, you can get a rough idea of the soil texture.

Follow the procedure below to determine the texture of a soil:

1. Take a soil sample the size of a small chicken egg (2 Tbs.) and add enough water to moisten it. The soil should form a ball when squeezed. If it crumbles, add some more water, and it gets too wet, just add some more dry soil. If the soil sample will not form into a ball, regardless of the moisture, you have **Sand**.
2. Place the ball of soil between your thumb and forefinger and gently push the soil forward with your thumb, squeezing it upward into a ribbon. Try to keep the ribbon uniform in thickness and width.
3. Does soil form into a ribbon? If yes, go on to #4. If no, you have **Loamy Sand**.
4. If soil forms a weak ribbon, less than 1" before breaking, you have **Loam**.
    a. Does soil feel gritty? If yes, you have **Sandy Loam**
    b. Does soil feel equally gritty and smooth? If yes, you have **Loam**
    c. Does soil feel smooth? If yes, you have **Silt Loam**.
5. If soil forms a medium ribbon, 1-2" before breaking, you have **Clay Loam**.
    a. Does soil feel gritty? If yes, you have **Sandy Clay Loam**.
    b. Does soil feel equally gritty and smooth? If yes, you have **Clay Loam**.
    c. Does soil feel smooth? If yes, you have **Silty Clay Loam**.
6. If soil forms a strong ribbon, 2" or longer before breaking, you have **Clay**.
    a. Does soil feel gritty? If yes, you have **Sandy Clay**.
    b. Does soil feel equally gritty and smooth? If yes, you have **Clay**.
    c. Does soil feel smooth? If yes, you have **Silty Clay**.

Name _____ Activity Sheet A

Scientists use a Soil Texture Triangle to determine the relative amounts of sand, silt and clay and then classify the soil into a texture type. Based on your ribbon test, decide where your soil fits on the Soil Texture Triangle below.



Soil Texture by Sedimentation

Another way to determine soil texture is by dividing the soil into its component parts using water to separate the particles.

Directions:

1. Fill a large (quart size) jar two-thirds full with water. Add soil until the water level is nearly to the top of the jar.
2. Cover and shake vigorously. Set the jar on a level surface and allow time for the particles to settle. The smallest particles may take overnight or even several days to settle.
3. Hold a piece of white poster board against the jar and mark the different layers on the board. Label these layers, from coarsest to finest (bottom to top), as sand, silt, and clay. Mark the top of the water level as well.
4. By measuring each layer of soil and the overall height of the water, you can calculate the percentage of each component and compare your results to the Soil Texture Triangle to determine the overall soil texture.

Name _____ Activity Sheet B

Just Passing Through

1. Describe your soil sample (color, texture, feel, shape of particles, size of particles, plant material, etc.)

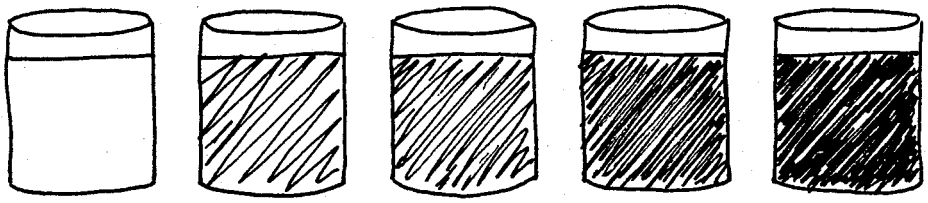
Hypotheses:

2. What do you think will happen when you pour water through the soil sample?

3. How long do you think it will take for the water to flow through the soil?

4. How much water do you think will pass through the soil sample?

5. What will the water look like? (Circle your prediction.)



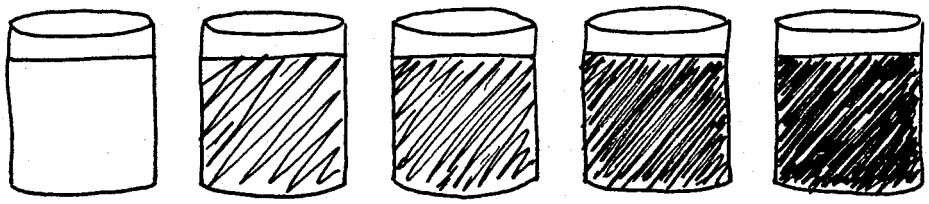
Observations:

6. What happened when you poured the water onto the soil?

7. How long did it take for the water to flow through the soil?

8. How much water flowed through the soil?

9. What did it look like? (Circle your observation.)



10. Did your observations match your hypotheses? In what ways?

11. What do you think would happen if you poured more water onto the wet soil?

12. 12.What can you conclude about this soil sample and its capacity to hold water?

13. What might this soil be good for? Explain your answer.