How does water move through soil?

Teaching and Learning Focus

You can help your students investigate the different ways in which water moves through soil particles.

Materials Needed

For each group of four students:

- 5 6-ounce clear plastic cups with four small holes punched in each with a ballpoint pen
- 5 10-ounce clear plastic cups
    - 1 graduated kitchen measuring cup or laboratory graduated cylinder
    - 1 pitcher of water
    - 1 large spoon or scoop for transferring samples to cups
    - Clear view of a classroom clock with a second hand

Enough of each of the following materials to fill a 10-ounce cup about 2/3 full:

- garden soil (use natural soil collected outside, not recently soaked with water)
- sand
- pea-size gravel
- dry powdered clay

Safety

This investigation is considered generally safe to do with students. However, please review it for your specific setting, materials, students, and conventional safety precautions.

Setting the Scene

Tell the students that they will test four materials for how much water they hold and how much water they allow to drain away in a

set amount of time.

Presenting the Investigation Question

After the scene is set, introduce your students to the investigation question: "*How does water move through soil?"*
Tell your students that they will be investigating this question and that at the end of their investigations, they will be able to provide reliable answers.
Have your students brainstorm ideas about how this investigation question could be investigated.

1. Design an experiment that could be used to test the investigation question.
2. What materials would be needed?
3. What would you have to do?
4. What would be measured?
5. How long would the experiment take?

Assessing What Your Students Already Know

If you have a potted plant growing in the classroom, show it to the class. Pick up the pot, and have the students notice that there is a hole in the bottom of the pot. Ask why the hole is there, and why they think you put a saucer under the plant. (Students will probably know that the hole allows water to drain.) Ask the students what would happen if you watered the plant and there was no drainage hole in the pot. (They will say that the soil gets "soggy", "too wet", "full of water". They may even say that this would not be good for the plant.)
Ask a student to water the plant as you hold it above the saucer. Let everyone observe water dripping from the drainage hole. Ask "Did as much water drip out of the plant as we put in the top?" Students will begin to think about soil's ability to hold water as they watch this occur.

Exploring the Concept

1. Show students that the 5 smaller containers, just like the flower pot in the classroom, have holes in the bottom through which water can drip. Demonstrate how the large cup can be inserted into the smaller cup so that water can be collected below. You might want to pour water in an empty setup so that they see how water passes through the hole to collect in the smaller cup below.
2. If your students are experienced investigators, you can challenge each group to design a fair test of the four materials (soil, sand, gravel and clay) using the materials you provide. You will need to approve the procedure before they begin their tests. As you review each plan, check that they have controlled the variables—volume of material, volume of water, time interval (if they ask, suggest they start with 15 seconds for all of the samples and adjust the time if that seems to be too long or too short for seeing results in the majority of the samples.)
3. Be sure that the students have set up a table for recording the results of the experiment. There are several ways that the students can collect their data. They can simply mark the cup with a line showing the amount of water drained in the given time period. (They can measure the height of this line using length units.) Or, they can actually measure the drained amount using the measuring cup or cylinder.
4. Have the students perform their experiment, record their data, and, finally, display their data on a bar graph (histogram). Give them time to share their fair tests and their results.

Applying Students' Understanding

Ask the students to look at the data they collected in the experiment. Ask them to rank the four materials from the one that allowed the most water to pass through to the one that allowed the least. Ask why they think this is so. Discussion should lead to an observation of the importance of particle size. Water passed most quickly through the large pieces of gravel and most slowly through the very fine powdered clay. Turn students' attention to the natural soil that represents a mixture of particle sizes. *Did it let as much water through as gravel and sand?* [No.] *How did it compare to clay?* [More water passed through it than clay.) Ask the students to *recall what else they found in their soil mixtures in the first activity*. [They should recall seeing bits of plants and animals—organic material.]
You can show your students that the organic material in the soil also contributes to its ability to retain water. Put a small amount of dampened (not soaked) peat moss or sphagnum moss in one of the cup set-ups and pour a measured amount of water through.

Students will see that the organic material helps soil to hold more water.

Revisiting Investigation Question 3

Complete this investigation by asking your students to reflect on the investigation question and how their answers may have changed as a result of what they have learned. Ask them why they think it's important for water to move through soil. Remind the students that how well a soil holds onto water and how well it drains water helps plants to grow. Elementary students know the importance of watering plants with just the right amount of water—not too much and not too little.

Tell students (or show photos to illustrate) that growing plants is not our only interest for measuring how well soil holds water. People building houses need to know how well the surrounding soil is able to drain water. In many areas, septic systems collect and drain household waste water away from the home and its water supply. For the systems to work properly, the soils must drain at a certain rate or the septic system backs up.

Digging Deeper

The extent to which soil holds or releases water is dependent upon the types of particles in a soil sample. Soil is likely to have several kinds of rock and mineral particles. A few kinds are very common. The three most common kinds are quartz particles, feldspar particles, and small pieces of rock. A soil sample is very likely to have a lot of at least one of these three kinds of particles. Quartz particles have irregular shapes. They look gray and glassy. Their surfaces are often stained brown or orange, because they are coated with rust. Feldspar particles are usually white or cream-colored. Their surfaces are often flat, at least partly, rather than irregular. There are many kinds of rock particles. You can tell them apart from the mineral particles because rocks are made of many different particles of minerals, all stuck tightly together.

The finest part of a soil sample is probably mostly very small flakes of clay. They are too small for you to see even with a hand lens. Sandy soils are loose and easy to dig. Soils with a lot of clay are harder to dig. Some plants like sandy soils and others like soils with more clay. Most soils have lots of organic matter. Some of the organic matter is in the form of living things, such as earthworms, insects, and microorganisms. Most soils are also rich in decaying plants. If the plant has decayed only slightly, you can usually recognize scraps of leaves, roots, and seeds. When the plant has decayed more, it turns into a soft, fine, dark material called humus. Humus is very important in soils. New plants can easily put their roots into humus. It is also good at holding water for later use by growing plants.

Soil Unit Sections