Activity Description & Estimated Class Time

In this two-day activity, students will analyze local soil to determine its composition and apply their knowledge of soil components to design a soil column that allows water to move through it at a specified rate.

Correlations to NC Science Standards

ESS.6.2.3 Use models to explain the rock cycle and its relationship to the formation of soil (including how different types of soil come from different types of rocks).

Learning Target

Students will demonstrate knowledge and understanding of:

- how soil is a mixture of rock particles, minerals, decayed organic matter, water, and air.
- different soils have many properties (e.g., texture, particle size, pH, fertility and ability to hold moisture).
- soil's ability to support structures and plant growth, depending upon the combination of properties

Brief Science Background

Soil is made up of many different materials, including tiny pieces of rock, minerals, air, water, and organic matter. The exact mix of these materials can change depending on where the soil is found. A key property of soil is particle size distribution, which determines soil texture. The three primary particle types are:

- Sand (largest particles; 0.05–2 mm): gritty texture, large pore spaces, rapid drainage
- Silt (medium particles; 0.002–0.05 mm): smooth or floury texture, moderate water retention
- Clay (smallest particles; <0.002 mm): sticky when wet, very small pore spaces, high water retention

Most soils are a mixture of these particle sizes, and their relative proportions define the soil's texture.

Particle size also affects how water moves through soil. Soils with larger particles have more space between them, allowing water to pass through more easily. Soils with smaller particles have less space, so they hold water longer. This property is important because it influences plant growth, water availability, and how the ecosystem functions.

Understanding soil texture and water dynamics helps explain real-world phenomena such as plant distribution, agricultural productivity, erosion, and groundwater movement. Soil scientists use these properties to classify soils and make decisions about land use and environmental management.

Part 1 - What's In The Soil?

Materials

Materials for the whole class

- Soil Samples
- Liquid Dish Soap
- Water
- Trowels

Materials cont.

Materials for groups of 2 students

- Plastic Vial
- Paper Plate with dry soil
- Spoon
- Soil Studies Student Activity Sheet, SD 1, 1 per student

Preparation

1. Collect soil samples and allow the soil to dry. Document where you collect the sample to share with the students.
   Collecting samples from different areas can enable deeper analysis and understanding of soil components.
2. Place enough soil to fill a vial on each paper plate.

Procedure

1. Give each group their materials and explain to them where their soil sample is from. Have students record this on their Soil Studies Student Activity Sheet, SD 1.
   If you collected samples from different areas, show the class a map and have them document.
2. Have students use the spoon to separate the soil into piles of similar things. For example, sand, rock, clay, leaves, stems, and roots. Ask "What do you notice? How do you think these things got to be where you found them?"
3. Explain to students that soil is made up of a variety of living and nonliving things, and these things can vary depending on where the soil is found.
4. Have students look again at their soil and all the things that are found in it. Ask "What do you notice about the particle sizes?" Now, tell students they will explore the different particle sizes that make up soil.
5. Have them fill their vial about half full with soil.
   They should try to exclude leaves, stems, and roots.
6. Next, have them fill the plastic vial with water, leaving a little room at the top.
7. Place one drop of liquid dish soap into the vial and then have students put the lid on tight.
8. Demonstrate to the students how to rock the vial back and forth gently to mix the soil, water, and soap. Then allow students to repeat.
   Make sure students hold the lid on the vial as they rock it back and forth.
9. Set the vial down. After one minute, have students record their observations on SD 1. Wait ten more minutes and record their observations again.
10. Have students, **EXCEPT FOR YOUR LAST CLASS**, clean and rinse all tubes for reuse. The last class should leave the vial undisturbed for 24 hours. Inform students that they will look at an undisturbed vial the next day, record their observations, and draw what they see. Explain that soil scientists use this technique to separate soil by particle size.
11. The next day, have students look at the undisturbed vials, record their observations, and draw what they see on SD 1.

Content Connection

1. Have students locate the different layers by particle size and mark them on their drawing.

Content Connection cont.

2. Hold a class discussion about what they notice about the size of particles in the different layers and the way they settled.
   Students observe sedimentation, a process in which particles settle out of suspension based on size and mass. Larger, denser particles (sand) settle quickly, followed by silt, while clay may remain suspended for a long time before forming the top layer. The dish soap acts as a dispersing agent, helping separate particles by reducing clumping.

Part 2 - Soil and Water Challenge

Materials

Materials for the whole class

- able to project Soil and Water Challenge, SD 3
- several buckets or dishpans into which students can dump water as they experiment with different soil mixtures and clean tubes, provided by teacher.

Materials for groups of 4 (students will work in pairs)

- gravel, sand, and clay and a scoop for each
- plastic tubes (tubes will need to cleaned out and reused for all classes)
- 9 oz cup of water
- 2 droppers
- 2 timers
- 2 hand lenses
- 2 rulers
- Soil and Water Challenge Student Activity Sheet, SD 2, one for each student
- 2 pieces of paper, provided by teacher

Preparation

1. Prepare the soil components, scoops, and cups of water for distribution.
2. Have 3 tubes ready for demonstration, one each of gravel, sand, and clay. Be sure the tubes are filled 3 inches deep (the surface of the soil should be 3 inches from the bottom of the tube). Have a dropper full of water and a timer ready.
3. Set up several stations with dishpans or buckets into which students can dump water as they experiment with different soil mixtures and clean tubes.
4. Before this activity, ask students to read text about soil and soil components.

Procedure

1. Set up teams of 4 at a table, made up of 2 pairs. Pairs are to work together and share gravel, sand, and clay. Give out scoops for each material, hand lenses, a cup of water, droppers, rulers, timers, and Soil and Water Challenge Student Activity Sheet, SD 2.
2. Ask students to place a small amount of each soil component on a piece of paper and observe it with a hand lens. Also ask students to touch each component. Have students record their observations on SD 2.
3. Ask what happens to water that falls on the ground when it rains.
   Students will generate many different answers. If one includes water running into the soil, ask where the water goes in the soil. Try to bring out the idea that there would have to be spaces in the soil for the water to go into.
4. Hold up a tube of gravel and ask what will happen to the water when you squeeze a dropper full into the tube. Ask them how long they think it will take for the water to reach the bottom of the tube. Have students record their prediction on SD 2.

Procedure cont.

5. Squeeze the water into the tube of gravel for all to see and time how long it takes for the water to reach the bottom of the tube. Have students record the results on SD 2.
6. Discuss results and ask for predictions of what would happen with sand or clay in the tube.
7. Repeat the same procedure with sand and clay and compare results among the 3 substances.
8. Project the Soil and Water Challenge, SD 3, and explain the challenge to the class. **Challenge:** Each pair of students will receive all 3 soil components and a tube. Their challenge is to manipulate the soil mixture in the tube so that water reaches the bottom exactly 30 seconds after it is placed at the top of the tube. The tube must be filled to 3 inches from the bottom. Time begins when the first drop of water hits the soil and ends when the first drop of water reaches the bottom of the tube. Students may:
   - use any soil component or combination of soil components in the tube,
   - use any amount of water, a little or a lot, but they must drop it in with the dropper,
   - apply the water from the dropper however quickly or slowly they want.
9. Explain that each pair must record each trial on SD 2 with:
   - an accurate description of the soil components in the tube,
   - a description of how they added the water,
   - the time it took the water from the time they added it until it reached the bottom.
10. When students succeed, challenge them to repeat their results.
11. Have students clean and rinse all tubes for reuse. Tubes with clay that are too difficult to clean may be discarded. Extra tubes included in the kit are to replace clay tubes that might be discarded. Do not flush gravel, sand, or clay down the drain.

Content Connection

Have students answer the following questions then discuss as a class:

1. A farmer is considering buying land to grow corn. If rain immediately sinks below the surface of this land, the roots of his corn will be dry a few hours after the rain falls. On the other hand, if rain pools at the surface, the roots remain wet and rot. Discuss with the class what mixture of soil types is the farmer looking for.
   The farmer needs soil that holds enough water for the corn roots but also drains excess water so the roots do not rot. A balanced mixture, typically about 40% sand, 40% silt, and 20% clay, provides good drainage and enough water retention to keep corn roots healthy.
2. Land far from towns cannot be served by a town's sewer system. To build homes there, people use a system that treats sewage in a tank. The system then disperses wastewater just below the surface of the ground. If the soil is the right type, water sinks into the earth. If it is the wrong type, water rises to the top in rainy weather, causing a health hazard. What mixture of soil types should a homebuilder look for?
   The homebuilder needs soil that allows wastewater to soak into the ground without draining too quickly or pooling at the surface. The ideal soil is called sandy loam, a mixture of 65% sand, 25% silt, 10% clay. Sand allows for drainage, silt and clay filter contaminants, and by avoiding excessive clay it will prevent surface ponding.

SD 1

Soil Studies: Student Activity Sheet

Name:

Where is the soil sample from?

Separate the soil into piles of similar things. What do you notice? How do you think these things got to be where you found them?

Record your observations in the table below:

Time	Observations
1 minute	
10 minutes	
24 hours	

Draw your vial after 24 hours.

Soil scientists use this technique to separate soil by particle size. Look at your vial and see if you can locate different layers based on particle size. Mark those layers and label them on your drawing.

What do you notice about the size of particles in the different layers?

SD 2

Soil and Water Challenge

Challenge: Manipulate the soil mixture in the tube so that water reaches the bottom exactly 30 seconds after it is placed at the top of the tube. The tube must be filled to 3 inches from the bottom.

You may:

- use any soil component or combination of soil components in the tube,
- use any amount of water, a little or a lot, but you must drop it in with the dropper,
- apply the water from the dropper however quickly or slowly you want.

SD 3 Soil and Water Challenge: Student Activity Sheet

Name:

Place a small amount of each soil component on a piece of paper and observe it with a hand lens. Describe each of the three soil components, including what it feels like.

Gravel -

Sand -

Clay -

Substance	Prediction (s)	Actual Time (s)
Gravel		
Sand		
Clay		

For each trial record:

- an accurate description of the soil components in the tube,
- a description of how they added the water,
- the time it took the water from the time you added it until it reached the bottom