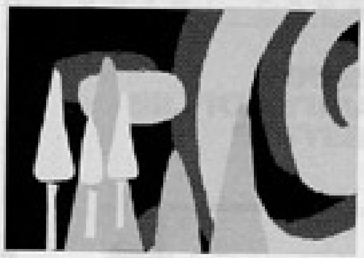

Overview

Students often wonder why certain plants grow in some places and not in others. Climatic factors such as temperature, moisture, and sunlight keep palm trees in Florida and fir trees in Oregon, but subtle differences in soil allow an oak to compete more successfully in one area and a maple in another. In this activity, students will explore differences in soil types and what they mean to us.

LEVELS
Grades 5-8

SUBJECTS
Science, Math, Social Studies

CONCEPTS

- The structure and scale of an ecosystem are influenced by factors such a soil type, climate, availability of water, and human activities. (10.2)
- Conservation and management technologies, when appropriately applied to the use or preservation of natural resources, can enhance and extend the usefulness of the resource as well as the quality of the environment. (11.2)

SKILLS
Observing, Identifying Attributes and Components, Concluding

OBJECTIVES
Students will ① identify components of soil and how these components determine its function, ② explain how different soil types determine the characteristics of ecosystems, and ③ predict the influence of soils on water filtration and on human use of an area.

MATERIALS
Part A: for each student-copies of student page 256, hand lens (could be shared within group) for each team-small plastic bag, trowel or shovel, beaker or jar, stirring rod or jar lid, 100-ml graduated beaker for the entire group, scientific balance scale, water
Part B: for each group-set of instructions on student page 257, food can (soup size) with both ends removed, measuring cup, watch that keeps time to the second, 20-penny nail, flat board and hammer (optional), ruler, paper and pencil, water-carrying container, water
Enrichment: soil survey book; radish seeds; growing containers and flower pots with holes in bottoms; graph paper; various soils including gravel, loam, sterile sand, powdered clay, or peat moss; paper towels

TIME CONSIDERATIONS
Preparation: 60 minutes
Activity: Two 50-minute periods

Background

Soil, the foundation for life on Earth, is a mixture of ***mineral*** ingredients (rock, clay, silt, and sand); ***organic*** ingredients (living organisms, decomposing organic matter); moisture; and air spaces. Soils are often classified by texture, which is determined by the amounts of clay, silt, and sand they contain. ***Loam*** is the term for a fairly equal mix of all three. Other soil textures are heavier on one element than another, i.e. silt loam, sandy loam, clay loam, sandy clay, and so forth.

The ratio of these components in relationship to other environmental factors helps determine ① how well soil can sustain plants and withstand erosion, ② which plants will grow well, or ③ whether the soil can support development.

Another important component of soil is the spaces between soil particles. These spaces are critical to plant growth, since they are where roots grow and where moisture and air are trapped. Moisture facilitates the transfer of nutrients to the roots.

Although soil may appear to be static, constant changes are actually taking place. For example, glacial deposits may change the amount of sand or rock in the surface soils; a fallen log will add organic matter as it decomposes; a stream can wash away fine silt, clay, and organic matter; or construction projects may move subsoil with less organic material to the surface. Various types of soils probably exist right on your school grounds. The table below describes the standards for common soil textures.

Getting Ready

This activity is most effective when students are able to collect and compare several different soil samples (try for five). Ideally, students can choose sites and collect the soil. Possible collection sites include low or wet spots, baseball fields, garden areas, overgrown fields, lawns, forested areas, or under trees. You may wish to scout around the school to find appropriate areas for digging and removing about 2 cups (470 ml) of soil.

NOTE—Remember to get permission from the property owners and to always wash your hands thoroughly after handling soil because it might contain contaminants.

COMMON SOIL TEXTURES

PARTICLE SIZE[a]	FEEL	NUTRIENT-HOLDING CAPACITY	AIR SPACE	H_2O AVAILABILITY
Sand 2.0-.05mm	gritty	low	many large	low
Silt .05-.002mm	smooth	medium	many fair/small	good
Clay <.002mm	sticky	high	few tiny	slow movement of water[b]

[a]To convert mm to inches, multiply by .04.
[b]Because pure clay compacts tightly into a solid mass, water may be suspended above the clay (as in a swamp or pond) or trapped below the clay, making it unavailable to plants. When clay is one component of the soil mixture, it reduces water movement so the soil feels moist.

If five different soils are not available near the school, consider these options:

- Ask students to bring in a plastic bag of soil from different sites around their homes.
- Use only two or three different sites, but obtain different soil types by digging deeper: surface soil, 6" (15 cm) deep, or 12" (30.5 cm) deep.
- Buy sterile sand (for sandboxes or concrete), peat moss (for gardening), and powdered clay (for pottery or sculpture) so you can make your own soil types. Use five different formulas to create variety (equal parts, three times more of one ingredient than the others, and so forth).

PART A
RECIPE FOR SOIL

Doing the Activity

1. What do plants get from soil? (air, water, nutrients, structural support) Do different plants have different soil requirements? (Yes. Some require dry soil, others need wet; some require acidic, others need basic.) How does this characteristic of having different requirements benefit plants? (Reduces competition for requirements.)

2. Tell students that you will divide them into teams, and that each team will analyze a different soil sample. Later, they will predict how well plants might grow in each sample and test their predictions (Enrichment for Part A).

3. Distribute student page 256, bags, and digging tools to each team.

4. Divide the class into five groups (or whatever number of different soils they will compare). Ask each group to collect a sample of soil (about 2 cups or 470 ml) from a different location. You can either assign locations or let them choose their own.

5. Back in the room, designate a study station for each team. Ask teams to examine their soil by answering questions on student page 256, and to compare their answers to other teams' answers. Distribute hand lenses to help students with their observations and comparisons.

6. Ask students about the importance of air spaces in soil (space for the air and water that plants need). Tell them they will measure the air space in their sample.

7. Give each team a beaker or jar. Have students measure 100 ml (6 cu in.) of dry soil (clumps should be broken up) in a graduated cylinder (or measure 1/2 cup = 118 ml), put the soil in their jar, and record the weight of the jar with the soil. Next, have students pour water into the jar very slowly until water reaches the top edge of soil. By weighing the container again, they can determine the weight of the water that filled up the air spaces in the soil (weight of jar with soil and water minus weight of jar with just soil). Because 1 gram of water displaces 1 milliliter of air, they can estimate the volume of air (ml) in each soil sample.

8. Discuss each team's results. What might have caused the difference? Invite students to hypothesize about the ratio of sand or silt to clay in each sample. (The silt and sand particles result in more air space.) The next step will test their hypothesis.

9. Have students continue to add water until the soil is covered with 2 inches (5 cm) of water. Cover the jar and shake it for several minutes, or vigorously stir the soil in a beaker. Allow the soil to settle for at least two hours; then observe the layers in each jar. Since larger components settle out first, soil particles will fall out of suspension in layers: Pebbles will fall first; then sand, silt, clay will fall; and some organic matter might float. Clay may make the water cloudy for a long time. Compare the layers in each sample. How do the results compare with their hypothesis?

10. Each group should prepare a verbal summary of its findings or create a poster that explains the components of the soil. After examining variations in these soils, discuss why vegetation might grow differently on those sites. Lead a discussion comparing the soil samples each team studied.

- Why did some have more organic matter? (perhaps the area has more vegetation)
- Which soil will drain water better: sandy loam or clay loam? (sandy loam because it has larger particles and air spaces)
- In which soil would a plant that needs a lot of water (willow or black spruce) grow best? (silt loam, which has small air spaces to retain water but will still drain fairly)

Enrichment for Part A

1. Before the shake test, distribute graph paper and ask students to estimate the portion of each component in their soil sample (how much sand, gravel, clay, or organic matter it contains). Then have them graph the result of the shake test to show a soil profile and to compare it with their original estimate. Compare soil profiles of different samples, and compare each soil profile to the amount of air space calculated for that sample.

- Set up an experiment to determine the "best" soil for young plants. Try sprouting seeds (radishes grow quickly) under several different soil conditions while maintaining equal amounts of sun and water. To grow the seeds, use the following:
  - Different soil samples collected in Part A
  - Moist paper towels (no soil)
  - Sterile sand
  - Peat moss

  Measure growth until noticeable differences can be detected.

PART B
A SOIL MYSTERY

Doing the Activity

1. Read the following mystery (in the side bar) to your students and have them discuss it in teams.

2. Lead a class discussion about the mystery. Help students identify the key questions: What is a perk test? How would it prevent someone from building a house? To find the answer to these questions, each team will perform a percolation (perk) test on soil from different areas.

3. Divide the class into teams of five. Distribute "Soil Percolation Test" on student page 257 and let your students get started. Circulate among the teams to help answer questions. If this process is too difficult for your students, you may conduct the perk test yourself as a demonstration.

4. When the groups finish summarizing their data, lead a class discussion about their results. Guide students toward understanding that dense or compacted soil has fewer air passages so that water percolates (drains) through it more slowly, while porous soils drain water very quickly.

5. Collect all the students' suggestions about the need for soil to drain near houses. Students should understand the need for soils to drain wastewater (discharged from sinks, showers, washing machines) for houses not connected to a waste water system and the need to prevent flooding from rains. On the other hand, soils that drain too fast may not properly filter impurities out of the water, which may result in contamination of groundwater (for drinking).

6. To solve the mystery, your students might suggest that the soil on Sam and Laticia's new property did not properly drain the wastewater and their house would not be hooked into a waste water system. This problem is not uncommon in more rural areas where the soil has large amounts of clay. What possible solutions might Sam and Laticia pursue to build their

For teachers to read...

SOIL MYSTERY

Two weeks ago, Laticia and Sam received a phone call from a lawyer who told them that Sam's grandfather, who had recently passed away, had willed a piece of land to them. They now owned the property and could do with it whatever they wished.

It didn't take long for Sam and Laticia to decide what to do with the land. They had often dreamed of building their own small house. They were both good carpenters and were sure that with some boards and bricks and a lot of work, they could make a fine house for themselves.

When Sam and Laticia went to visit their new property, their dream seemed as if it would come true. They started right away by filing the proper building permit and having the site tested for a well by having a percolation (perk) test done.

When they received the test results, their hearts sank. The soil on the property had failed the perk te[st] and they would not be ab[le] to build their dream hous[e]. Why not? What was wr[ong] with the soil?

dream house? (Some of these are expensive solutions.)

- Conserve water to produce less wastewater and reduce the burden on the house's septic system.
- Build a cesspool to hold wastewater.
- Dig a large, deep pit and fill it with gravel, sand, and soil to increase the drainage ability.

Students may also have suggested that the soil drained too quickly and might allow contamination of well water. How could this problem be solved? (by installing equipment that filters wastewater before allowing it to enter the groundwater)

Enrichment for Part B

1. Ask your state Natural Resources Conservation Service for a copy of your county's soil survey. The book will contain aerial photographs of your county, marked with the different kinds of soil. Soils will be rated by texture (such as sandy loam) and qualified for appropriate uses (such as agriculture, highways, housing, and so forth).

By matching their knowledge of local areas with the soil survey, students can see how land-use patterns correlate to soil classifications. If a new development is proposed for your county, students can check the soil survey to see if the soil type is suitable for that development.

2. Here are additional soil mysteries for your students to investigate:

- A mudslide destroys homes. What soil conditions caused this to happen? (Soils of different textures overlapped, for example, a coarse-textured soil over a fine-textured soil caused moisture to build up at the point of contact, which in turn caused the coarse soil to slide over the fine soil on a slope).
- A building's foundation cracks as soil subsides. What soil type would cause this to happen? (Soil with a high organic content tends to subside as organic matter is broken down.)
- A flood in a city is blamed on increased runoff. What caused the runoff? (Soil has been paved over for streets, sidewalks, or parking lots.)

3. To demonstrate the drainage properties of different soil textures, use a flower pot with drainage holes in the bottom. Place different soils in the pot. As a student pours water into the pot, have the class count aloud until water leaks from the bottom. Use gravel, sand, loam, and, finally, clay.

Explain that some trees need soils that hold a lot of water, while others need drier soils. Here are examples of trees and their preferred soils:

- Poorly drained soils—cedars, red and silver maples
- Moderately drained soils—hemlocks, red spruces, balsam firs, aspens
- Well-drained soils—white pines, white birches

It is possible to predict the type of soil under your feet by recognizing the kinds of trees growing there. Likewise, you can tell what trees will grow best on a piece of land if you know the soil type.

END NOTES...

ASSESSMENT OPPORTUNITY

Have students imagine they are inspectors for your county's Soil Conservation Service. They must write a letter to Sam and Laticia explaining what the results of the perk test indicate. They should explain the reasons Sam and Laticia cannot build a house on their property because of its present soil conditions. They can also explain what steps could be taken to prepare the land for building a house or what alternate uses the land could be prepared for.

RELATED ACTIVITIES

The Fallen Log; Nature's Recyclers; How Plants Grow; Field, Forest, and Stream

FOR PART A

SOIL INVESTIGATION

Team Members

____

____

1 Describe where the soil is from.

- Where was your soil site? Use words or draw a picture.
- What was growing on this site?
- Was it level or on a slope?
- What other things did you notice?

2 Describe the soil.

- What color is it?
- How does it smell?
- How does it feel? Roll some in your fingers.
- What do the largest soil particles look like? The smallest?
- How does your sample compare to the other soil samples?

3 Describe the air space.

- How much does the container with 100 ml of soil in it weigh?
- How much does the container with water to the top of the soil weigh?
- What is the weight of the water added to the container?
- What is the volume of air in this soil sample?
  NOTE—1 gram of water displaces 1 milliliter of air.
- Which soil sample has the greatest amount of air space?

4 Describe what is in the soil.

- What are the components of your soil sample after they have settled in the jar?
  Draw what the layers look like.
- How do they compare to the other samples?

SOIL PERCOLATION TEST

FOR PART B

SOIL PERCOLATION TEST

Getting Ready

1. Within your team, choose a person for each role:

- Equipment Monitor—collects equipment, keeps track of it, and returns it in good condition.
- Time Keeper—uses a watch that tells time to the second.
- Recorder—makes a data chart and records the time for each experiment.
- Facilitator—reads directions and helps everything get done.
- Checker—reads directions and makes sure everything is done correctly.

2. Have the Equipment Monitor collect the necessary equipment from the instructor. Have the Facilitator read the instructions out loud to the team and make sure everyone understands.

Team Instructions

1. Choose five different locations outdoors where there is a small patch of ground. Open soil, grass, leaves, or bushes are fine; asphalt, sidewalks, or concrete will not work.

2. At each location, record what is on the ground, and push one end of the can (which has both ends removed) 1" (2.5cm) into the ground. (It may be easier to rest a board on top of the can and firmly tap on the board with a hammer to push in the can.) Pour 1 cup (240 ml) of water into the can. Record how long it takes for the water to completely disappear. In some cases, the water will not disappear entirely during the class period. If this occurs, ask students to consider why all of the water does not percolate into the soil (The soil may already be saturated; the soil may be compacted at the ground surface; or there may be a hardpan layer near the soil surface.)

3. At each site, ask one person in your team to use his or her thumb to push a nail into the soil as far as it will go using moderate force. Then the student should measure the nail's height. Record this number.

NOTE—Try to use the same amount of force to push in the nail at each site. Do not use excessive force.

4. Rank your sites by how long it took for water to percolate; then present the data chart from your group. You may have students graph the results and present that data. Is there a relationship between nail heights and the time it took for the water to disappear?

5. What does the data tell you about the soil's ability to filter water, or to percolate? What assumptions can you make about the differences in soil you tested?

6. Why would a percolation test be important before someone builds a house? Why can't Sam and Laticia build their dream house?