Lesson Two:
SOILS

This lesson provides students with an opportunity to examine various soil types through multi-sensory explorations and models. Students will gain an appreciation for soil as the "great integrator" that supports life on Earth.

Part I. LESSON OVERVIEW

A. Learning Objectives

Upon completion of this lesson students will be able to:

- Describe and identify various types of soil by exploring soil samples and recording observations in small groups.
- Demonstrate the effect of different sizes of soil particles by pouring water through sand, silt, and clay.
- Graph results of a simple experiment involving sand, silt, and clay.

B. Correlation to State and National Standards and Guidelines

See chart

C. Textbook Compatibility

See chart

D. Materials

- Beakers, plastic (4)
- Clipboards-1 per student
- Clock or timer
- Soil samples in plastic containers with lids for 3 student groups labeled accordingly:
  - Sand (sample A)
  - Silt (sample B)
  - Clay (sample C)
- Soil laboratory
- Student journal sheets
- Wash bottles (one per group)
- Water pitcher

E. Advance Preparation

For a full description of how to build and use the model see the BUILDING AN ECOTEAM section of this site. Also, it is important to clean out the soil laboratory after each use. Allow

soil samples to dry out fully.

F. Key Vocabulary

HYPOTHESIS	An educated guess.
SOIL	The loose material that covers much of Earth's surface. Soil is a mixture of sand, silt, and clay.
SAND	This type of soil feels rough. It has a larger grain size.
SILT	This type of soil feels smooth and soft. It has a medium grain size.
CLAY	This type of soil feels sticky or slick. It has a smaller particle size.

G. References

Lesson was adapted from these sources:

The GLOBE Program. Global Learning and Observation to Benefit the Environment: Teachers Guide. Soils. "Jult Passing Through (Beginner Version)," 1997.

Project Food, Land & People. *Project Food, Land & People: Resources for Learning.* "Percolation Through the Pores." Chandler, AZ: Author, 1998, 121-123.

Ibid. Project Food, Land & People: Resources for Learning. "Till We or Won't We." Chandler, AZ: Author, 1998, 213-224.

Other sources:

Brewer, Richard. *The Science of Ecology*, 2nd ed. Ft. Worth: Saunders College Publishing/Harcourt Brace College Publishers 1994, 59-65.

Campbell, Neil A. *Biology*, 4th ed. Menlo Park, CA: The Benjamin/Cummings Publishing Company, Inc., 1996, 715-717.

Miller, G. Tyler. *Living in the Environment*, 10th ed. Belmont, CA: Wadsworth Publishing Company, 1998, 547-560.

PHASE II: LEARNING CYCLE APPLICATION

Phase One: Exploration (E)

1. Introduce and explain the exploration activity to the class. For example:
   In small groups you will explore soils through touch. Each small group will receive three soil samples labeled sample A, B, and C. Explore the soil samples one at a time. Be sure to read the instructions in your journal and record your observations. Also, be careful not to mix the different soil types together.

2. Divide the class into five student groups and designate a place for each group to explore the soil samples.

3. Distribute the soil samples to each group.

4. Allow student-centered exploration for 10-15 minutes.

5. Circulate through the classroom to answer questions or to help guide the students' explorations if necessary.

6. Announce to the students when they have five minutes remaining for their exploration.

7. Collect soil samples from each student group.

8. Explain to the class that you'll be helping them perform an experiment. The soil laboratory experiment will allow them to learn more about the soil samples they explored in small groups. Gather the class around the soil laboratory and describe the experiment:

Each tube contains a soil sample. In tube A, there is a sample of the soil sample A. In tube B, there is a sample of soil sample B. In tube C, there is a sample of soil sample C. Together we will measure 250 milliliters of water and pour it through one tube at a time. After one minute, you will record how much water passed through the tube and into the beaker. We will do this for each tube. Before we begin the experiment I'd like each of you to make an educated guess or a HYPOTHESIS. What tube will water flow through fastest? Record your hypothesis in your journal. This is your educated guess that we will now test in an experiment.

9. After students have time to hypothesize, conduct the soil laboratory experiment. Throughout the experiment emphasize the importance of being precise. Have the students help you accurately measure the amount of water to pour through each tube. Briefly discuss milliliters as a unit of measurement. Set the beaker on the table and have students look at the water in the beaker at eye level each time. Introduce beakers as tools commonly used by scientists in order to help make accurate measurements and observations. Stress the importance of accurate measurements in science.

10. Pour 250 milliliters of water through one tube at a time. Observe carefully, noting how much water moves through each soil sample after one minute.

11. Guide students to record their observations in their journals.

Phase Two: Concept Introduction (CI)

1. Next, discuss the experiment and introduce terms.

   - *Which soil sample did water flow through fastest?*
   - *Why do you think water flowed through sample A the fastest?*

2. Discuss the students' observations from Part A of the exploration.

- *How did sample A feel? Do you know what type of soil this is? Where have you experienced this type of soil before?*
- *How did soil sample B feel? Do you know what type of soil this is? Where have you experienced this type of soil before?*
- *How did soil sample C feel? Do you know what type of soil this is? Where have you experienced this type of soil before?*

3. Ask the children to read the definition for SOIL aloud.

> *SOIL is the loose material that covers much of Earth's surface. SOIL is a combination of sand, silt, and clay.*

4. Ask the children to read the definition for SAND.

> *SAND is a type of soil that feels rough. SAND is made up of large grains. There are large spaces between each grain of SAND.*

5. Next, introduce SILT. Ask the children to read the definition for silt aloud.

> *SILT is a type of soil that feels smooth and soft. SILT is made up of medium size grains. There are medium-sized spaces between each grain of SILT.*

6. Finally, introduce CLAY. Ask the students to read the definition for clay aloud.

> *CLAY is a type of soil that feels slick or sticky. CLAY is made up of very small grains. There are tiny spaces between each grain of CLAY.*

7. Ask the class to stand up and spread out. In order to help the children understand the differences in particle size between sand, silt, and clay, use actions to represent each soil particle. The children will represent the different soil types and the facilitator will represent a drop of water flowing through the soil type.

8. First, have the students pretend to be sand. Demonstrate how to represent sand. Stand with your arms outstretched and feet far apart. Walk through the classroom, moving easily through the students while discussing how easily water passed through the tube containing sand as sand particles are large with a lot of space and air in between each particle.

9. Next, demonstrate how to represent silt. Stand with your hands on your hips and your feet together. Move so that your elbows are touching another silt particle. Walk through the classroom, moving through the students by gently pushing their elbows apart. Discuss how water passed through the tube containing silt. However, less water passed through the silt than passed through the sand. Less water passed through silt because they are smaller particles with less space and air in between each particle.

10. Finally, demonstrate how to represent clay. Stand with your feet together and your hands at your sides. Move so you are standing side-by-side with other clay particles. Attempt to walk through the clay particles. The students will probably giggle as you struggle to pass by them. Discuss how no water passed through the tube containing clay. No water passed through the tube because clay particles are very small and tightly packed together. They are smaller than sand and silt particles. There is very little room between the particles.

11. Explain to the class that they will be graphing the results of the soil laboratory experiment:

    Graphs are a way to tell a story about something. We're going to use a graph to tell the story of our soil laboratory experiment. We will use a bar graph to show the amount of water that flowed out of each tube. A good graph will make it easy for other people to understand the story we are trying to tell. Before we begin, let's review the components of a good graph.

12. Have students turn to the graph paper in their EcoTeam Journal or hand out loose sheets of graph paper. As you and the students review the components of a good graph, begin constructing a graph on the board.

13. Circulate through the classroom to answer questions or help with the graphing activity.

Phase Three: Concept Application (CA)

EcoTeam Application Lesson and *Roots & Shoots Service-Learning Project*, please see corresponding sections of website.

PART III. BACKGROUND INFORMATION FOR FACILITATOR

A. General

Dirt is the non-scientific term used for soil. Soil is actually a mixture of air, INORGANIC MATTER, ORGANIC MATTER, and water, which supports life on Earth. Soil is a factory that provides food for all plants and animals, including humans. Soil covers most of Earth's land surfaces and plays a vital role in the natural processes of the environment. The following are just a few of the natural services that soils perform:

- Soils store and cycle nutrients (such as carbon or nitrogen) and water for plants and animals.
- Soils decompose inorganic and organic materials such as animal and municipal wastes.
- Microorganisms and other animals such as earthworms make their homes in the soil. Earthworms burrow through and mix the soil, opening channels for water and air to penetrate and provide life-sustaining moisture and oxygen to plant roots and animal and plant life in the soil.
- Water is filtered and cleansed as it flows through soils.
- Soils affect the chemistry of water as well as the amount of water that returns to the atmosphere to form rain.
- Soils make it possible for humans to grow food and other materials that we are dependent on for building, clothing, and paper.

Soil Formation & Types

Soils are composed of three main ingredients:

1. Minerals of different sizes;

2. Organic materials from the remains of dead animals and plants; and

3. Open space that can be filled with air and water.

Soil formation starts as the accumulation of loose materials from the breakdown of PARENT MATERIAL. Soils form in HORIZONS commonly called TOPSOIL, SUB-SOIL, PARENT MATERIAL, and BEDROCK. The soil formation process is a result of the complex and continuous interactions between the parent material, living animals and plants, climate, and topography. The interaction of these factors eventually develops a unique "personality" for each soil type.

Soils, like most things in the natural world, are dynamic and change over time. Some properties, such as temperature and water content, change very quickly over minutes and hours. Other properties, such as mineral transformation, occur very slowly over hundreds or thousands of years.

Soil formations and the properties of the soil are the result of five key factors. These factors are:

1. PARENT MATERIAL--The material from which soil is formed. Soil parent material could be bedrock, a deposit from glaciers, volcanoes, water, wind or material moving down a slope, organic material, or an old soil surface.

2. CLIMATE-Heat, ice, rain, snow, sunshine, wind and other environmental forces break down parent material and affect how fast or slow soil processes proceed.

3. ORGANISMS—Animals and plants living on or in soil from micro-organisms to humans. The amount of nutrients and water plants need affects the way soil forms. The animals living in the soil affect decomposition of waste materials and how soil materials will be moved around. The dead remains of animals and plants become ORGANIC MATTER that enriches the soil. The ways that humans use soil affect soil formation.

4. TOPOGRAPHY—The location of a soil on a landscape can affect how the climatic processes impact it. Soils at the bottom of a hill for example, will get more water than soils on the slopes. Soils on the slopes that directly face the sun will be drier than soils on slopes that do not.

5. TIME—All of the above factors assert themselves over time, often hundreds or thousands of years.

A particular soil horizon can be characterized by a variety of measures. TEXTURE is how soil feels—it is the amount of sand, silt and clay in the particular soil. Sand, silt, and clay particles in the soil are different sizes. Sand is the largest particle size group, and feels gritty to touch. Silt is the next size group, and feels smooth or floury. Clay is the smallest size group, and feels sticky and hard to squeeze. If a small amount is placed in the hand with water and rubbed, it feels slick. The actual amount of sand, silt, and clay size particles in a soil sample is called the PARTICLE SIZE DISTRIBUTION and can be measured in a classroom or laboratory. Since these particle sizes are difficult to visualize, the following analogy may help to clarify soil particle sizes, especially for younger audiences. If we enlarged sand particles to a human scale, sand particles could be the size of a basketball. Silt particles would then be the size of a golf ball, and clay particles the size of a dot made by a piece of chalk.

All clusters of soil particles have the ability to attract and hold water. Water moves quickly through sandy soils because of the large pore size or empty spaces between particles. Clay particles are so small that there is very little air or water space, so water moves slowly through clay. The

POROSITY of the soil, or the available pore space of a soil type, is therefore a major determinant of how quickly water moves through the soil. Water availability in soil is, in turn, a major factor determining plant communities growing in a given area.

B. Humans and Energy Flow

Understanding soil is important for humans for a variety of reasons. Humans are dependent on soil for the plants we use for food and fiber. Basic soil science is essential information for gardening and farming. Soil can also act like a sponge, providing natural flood control. It also recycles our wastes, such as in septic systems, and it can absorb and sometimes breakdown other pollutants. Understanding soils is important because it allows us to make good decisions about where to build our houses, playgrounds and roads, and where to grow our food.

C. Environmental Citizenship

Protecting our soil is necessary to produce the foods we need and to protect our water resources where sediment resulting from erosion can cause massive problems for aquatic ecosystems. Conventional agriculture practices contribute to topsoil loss, and the process of soil generation is very slow indeed. Understanding that soil is a living system is crucial to the healthy functions of the ecosystem (and not just a bunch of dirt!) may reduce the tendency to destroy or contaminate it.