Agriculture in the Classroom
UtahStateUniversity
COOPERATIVE EXTENSION

Texturing: The Big Picture

Soil, Water, and Plant Growth

Purpose
Students will explore soil textures and understand the basic components that make up the "dirt" under their feet.

Time: 1 hour

Grade Level: Elementary

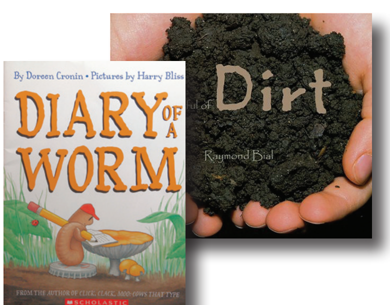
Materials

Activity 1
- ❑ 4 sheets of each of 60, 220, and 1000 grit sandpapers
- ❑ Hand lenses (1 for each pair of students)

Activity 2
- ❑ 4 jars with tightly fitting lids
- ❑ 4 soil samples (sand, silt, clay, and loam)
- ❑ 1 ruler

Activity 3
- ❑ 6 Styrofoam cups
- ❑ 6 clear cups (to hold Styrofoam cups)
- ❑ 2 cups of sand
- ❑ 2 cups of silt
- ❑ 2 cups of clay
- ❑ 9 bean (or other large) seeds
- ❑ 9 lettuce (or other small) seeds

Activity 4
- ❑ 2" x 1.5" sticky notes in four colors
- ❑ Magazine pictures (optional)



Recommended Books: A Handful of Dirt *and* Diary of a Worm

Background

Rocks are generally classified by the content of minerals and chemicals, the texture of their particles, and the process of heating and cooling that formed them. Rocks are classified as igneous, sedimentary, or metamorphic. They can be further organized by particle size. Rock may undergo changes from one type of rock to another based on the environment; this is called the rock cycle. The rock cycle is greatly influenced by water. Water (both flowing and as ice), hot and cold temperatures, and wind influence the weathering and erosion of rocks. This process creates the mineral matter found in soil.

Soil is found on the surface of the Earth's crust. Soil is composed of four elements: air, water, humus (once-living organisms such as bark, leaves, and pinecones, etc.), and non-living mineral matter (weathered rock). Often the question is asked, "Is soil alive?" The soil, as a single, living organism is not alive; however, there is so much life in soil (bacteria, fungi, and insects) that many Native American cultures consider soil to be alive. Soil is very important; we need soil to grow the plants we eat, the plants we wear, and the plants (trees) that provide us shelter.

Soil particles come in three sizes: sand, the largest particle, followed in descending size by silt, and clay. Clay is so small that the particles are actually impossible to see without magnification. Amazingly, you can feel the difference! A mixture of all three particles in a soil is called a loam. If the predominant particle in a soil is sand, then the soil is termed a "sandy loam." If more clay is present in the soil, then the soil is called a "clay loam," and likewise with silt in a "silty loam." To determine accurately the texture of a soil, farmers and soil scientists "break-up" the soil particles with a type of "dirt shake" (hydrology test) to separate soil particles to measure the amount of sand, silt, clay, and humus in a soil sample. Air exists in the pore spaces between the soil (mineral) particles. When a soil is dry there is more air in the soil, but when wet there is very little air in the soil because the water has filled in the spaces! Soil is rarely completely dry; there is usually at least a small amount of moisture in soil. Some plants are aquatic and thrive in saturated soils, but many others do not. Most land-based plants need air in the soil to grow. The humus, or organic matter in soil, is made up of once-living organisms. The humus, along with the minerals in the soil, provides important nutrients for plants to grow.

Hand texturing (using the hands to feel the soil) confirms the texture of a soil, and is used widely in the field when a hydrologic "dirt shake" test is not practical. Sand, whether dry or wet, is gritty. Silt, when dry, feels soft and powdery, when wet it feels smooth and slick. Clay is usually hard and clumped when dry, but if ground down it is also powdery like silt; however, when clay is wet it becomes very sticky and may stain your fingers, and this is the best way to tell silt and clay apart. Stepping into and then out of a wet clay soil can pull your shoe off! The characterististics common to all clay minerals derive from their chemical composition, layered structure, and size. Clay minerals all have a great affinity for water. Some swell easily and may double in thickness when wet. Water molecules are strongly attracted to clay mineral surfaces. When a little clay is added to water, a slurry forms because the clay distributes itself

Vocabulary

rock—the solid mineral material that forms part of the earth's surface

soil—particles of minerals, organic matter (plant and animal), water, and air that is found on most surfaces of the land

dirt—misplaced soil, i.e., soil on your clothes, your kitchen floor, and under your fingernails

sand—a loose, granular, mineral component of soil; has the largest particle size of the three soil components

silt—also a component of soil but consisting of a sedimentary, mineral material and having a dusty consistency; has a particle size in between sand and clay

clay—the smallest of the three component of soil; made up of fine-grained mineral and having a stiff, sticky consistency when wet

loam—soil that is a roughly equal mix of sand, silt, and clay

humus—the organic matter in the soil that is formed when leaves and other plant and animal-based materials break down

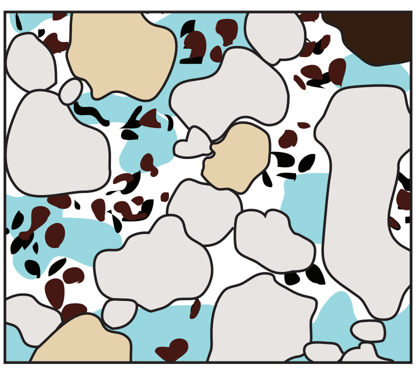


Illustration of soil particle mix with sand, silt, clay, water, air, and organic matter.

**Note: Sandpaper is not actually made out of soil particles. Sandpaper grit is made from a mineral, bauxite, that is mined, heated, and crushed to an exact size for various sandpapers. The sandpaper used in this activity provides a tactile experience for understanding particle size.*

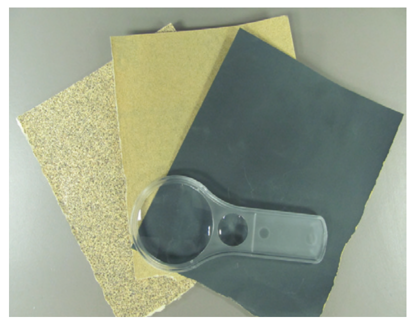
evenly throughout the water. This property of clay is used by the paint industry to disperse pigment (color) evenly throughout a paint. Without clay to act as a carrier, it would be difficult to evenly mix the paint base and color pigment. A mixture of a lot of clay and a little water results in a mud that can be shaped and dried to form a relatively rigid solid. This property is exploited by potters and the ceramics industry to produce plates, cups, bowls, pipes, and so on.

The process by which some clay minerals swell when they take up water is reversible. Swelling clay expands or contracts in response to changes in environmental factors (wet and dry conditions, temperature). Hydration and dehydration can vary the thickness of a single clay particle by almost 100 percent (for example, a 10-inch thick clay mineral can expand to 19.5 in water). Houses, offices, schools, and factories built on soils containing swelling clays may be subject to structural damage caused by seasonal swelling of the clay portion of the soil.

Soil texture cannot be determined by the color of the soil. There is red sand in Utah and red clay in Oklahoma. The color of a soil is based on the amount of humus and the mineral matter in the parent material or rocks from which the soil originated.

Activity Procedures

*Activity 1: Sandpaper Texturing**



1. Fold each sandpaper sheet into four quarters, then cut or tear the sections apart so that you get four pieces from each sheet.
2. Provide each group of three or four students with a sample of the 1000, 220, and 60 grit sand paper and a few hand lenses.
3. Ask students to touch each sample and to place them in order, from grittiest (coarsest or roughest) to the softest (smoothest) sample.
4. To check their accuracy, ask students to use the hand lens to look at the grit on each sample and verify if they have the samples in the correct order, largest grittiest particle to smallest smooth particle. If students have the sandpaper in the correct order, they are on their way to being able to texture soil by feel.

Activity 2: Dirt Shake Demonstration

1. Gather four different types of soil, preferably finding one that contains more sand, one that contains more silt, one that contains more clay, and one that is a mixture "garden soil" or loam. (You may purchase soil samples that have been evaluated as primarily sand, silt and clay from Utah Agriculture in the Classroom; these pure samples will make it easier for your students to see the differences between textures). Review with students that sand is the largest particle, silt is the next size, and clay the smallest. In order to determine the texture of each sample, measure and place 2-inches of sand, silt and the loam into indivudal jars. Measure and place a 1/2-inch of clay into a jar, remember that clay expands so **do not add** more than 1/2-inch into the clay jar).
2. Remind students that soil also contains air, and while air is invisible, when water is added to the soil sample they should be able to see air bubbles rising to the top. Add water to each jar (observing the bubbles) so that the jar is 2/3-3/4 full. Ask students if they noticed the air bubbling to the top. The air, trapped between the particles has been displaced, or forced out by the water.

Holes poked in Styrofoam cup.

Soybean germination after one week, from top to bottom: potting soil, sand, silt and clay.

3. Tighten the lids and shake one jar vigorously until all the particles have been sufficiently separated by the water, about 2 minutes will work for most samples. Soil scientist shake soils for 24-hours—it can take this long to break apart some clay particles, but in the classroom you will have adequate results from a short amount of shaking.
4. Set the jar down and allow the soil to settle for 1 minute, then measure the amount of soil on the bottom of the jar. This is the sand (largest particle layer). Record this information. The next layer to settle will be the silt layer. It may take an hour or more to see this layer develop. Measure again when you see that the layer has formed. The clay particles will be the last to settle and may take 4 or more hours to form the last layer (some very clayey samples could take a week or more). Measure this layer when the time comes.
5. Repeat this "dirt shake" experiment with the remaining samples and record the information for comparison. A soils scientist will be able to use the measurements to determine the actual soil texture, but for young students, seeing the differences will be meaningful. You should be able see the greatest layer distinction in the "garden" loam soil jar, because the other samples are fairly pure.
6. Your students may observe "stuff" floating on the surface of the water. This "stuff" is the "once-living" plants—the organic matter or humus. If you make a dirt shake out of potting soil from a bag you will notice that the entire sample will float. Why? Because there is no mineral matter, just humus (peat moss)!

Activity 3: Which Soil is Best?

1. To demonstrate how different soil types may affect plant growth, plant a large seed (bean) and a small seed (lettuce) in separate containers of sand, silt, and clay. Poke three holes of the same size in the bottom of six Styrofoam cups. Next, fill the cups with the soils, adding two of each soil type to within two inches of the brim. Place three bean seeds and three lettuce seeds in each soil type. Place the Styrofoam cups into clear plastic cups to collect any water that may drain out. Water with 40 ml every 4 days. Note how the different soil types absorb the water and how the water flows through other soils. Do all the soils look like they need water? Discuss what might happen if you didn't water for another week.
2. Ask students to predict how the different seeds may react to the different soils. Do they have any predictions? What are their predictions based on? Examine the size of the seeds—are big seeds stronger than smaller seeds? Consider the texture of the soils—do some soils hold more water than others?

Soybean growth after 2 weeks. From left to right: potting soil, sand, silt and clay.

Lettuce growth after 2 weeks.

Lettuce growth after 3 weeks.

Soybean dug-up after 2 weeks. Clay absorbed most of the water making the water unavailable to the seed.

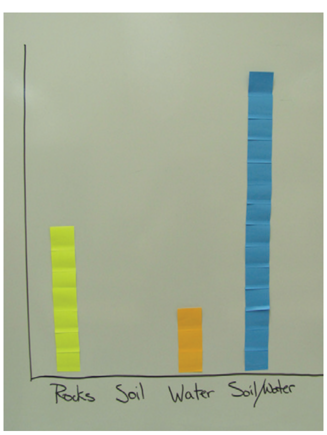


Figure 3: Graph of personal use of rocks, soil, and water.

3. Be sure to observe the cups each day. Are some textures drying out more quickly than others? There are many variables that can effect seed sprouting and plant growth, so you will want to make sure that other than the seed and soil types, all the other variables, such as temperature, light, and water, are identical. This "controlled" experiment doesn't exactly duplicate what is seen in a farmer's field. The intensity of the sun or wind may bake and dry a clay soil and cause a crust to form on the top of a soil, keeping a seed from sprouting. Also, clay soils take longer to dry out than a sandy soil, so if the weather is particularly wet, a seed may rot before it can sprout. These are just some of the variables farmers' work with. They need to know their soil and monitor the weather to pick the perfect time to plant. Farmers hope that the weather (temperatures and moisture) doesn't negatively impact their crop.

Activity 4: Graphing My Personal Use of Rock, Soil, and Water

1. Using the four different colored sticky notes, assign rocks, soil, water, and other items that would use a combination of these resources, each a color. These colored sticky notes will be used to create a graph on the whiteboard.
2. Ask student to draw pictures or cut out pictures from magazines of things they have used in the last week. To accelerate the activity, you may provide images of items to the students.
3. Have each student share their picture and decide if the item needed rocks (remember that rock can contain metal), soil, water, or a combination of these resources. As the students identify the resources their item used, provide each student with a corresponding color of sticky note.
4. Ask students to help you place the sticky notes in the appropriate place on the whiteboard graph you have constructed.
5. Review the graph for trends that appear. It is likely that the items students use everyday require soil and water!

Additional Activities

- Emphasize the uses and importance of soil by viewing the sing-along song "Dirt Made My Lunch," by the Banana Slug String Band; available on YouTube.com.