What Is Soil?

Objectives The student will identify the major components of soil.

The student will be able to distinguish different soils based on physical characteristics.

Grade Level	1-3	4-6
TEKS:		
	S- K.10,A,B; 1.10A,B; 2.10.B; 3.11A,B	S- 4.11A

TAKS:	GRADE	OBJECTIVES
Reading:	3, 4, 5, 6	1, 4
Writing:	4	1, 2, 3, 4, 5, 6
Science:	5	1, 2, 3, 4
Math:	3, 4, 5, 6	1, 4

Assessment Summary:

Materials: Rock
Leaves, twigs, grass clippings
Sand
Commercial top soil (Play sand and top soil can be purchased from lumber yard or garden center.)
Paper plates
Zip Lock bags for students, soil samples
1 or 2 liter plastic soda bottles, with lids. One per student
Water

Equipment: Magnifying lenses

Assessment:

1. Observation of activities.
2. Oral responses using What is Soil? Review.
3. Grades 1-3: Descriptive sentences and paragraphs
4. Grades 4-6: Compare and contrast compositions.

Background Information

WHAT IS SOIL?

How Is Soil Formed?

Soil is the loose top layer of the earth's surface in which plant life grows and on which we walk. Soil is made of many things. Minerals, pieces of rock, living organisms, bits and pieces of decaying plants and animals, water, and air can all be found in different amounts, depending on the soil type.

Soil is formed over many years. Soil originates from parent material, or rock, which is slowly ground into smaller particles by friction, temperature changes, freezing water, and chemical action. When rocks grind against each other small particles are scraped off. This can happen as rocks tumble around in a stream of water. Rocks found in a river or stream are usually smooth and rounded because of this grinding action. Glaciers that moved across a big part of the United States many years ago ground up huge quantities of rock. Much of the soil in the north central United States was formed by the action of these glaciers.

Changes in temperature also help to make soil. Rocks warm up from the sun during the day and expand. At night the rocks cool and contract. This expansion and contraction chips away at the rock, reducing it into smaller and smaller particles.

When water finds its way into cracks in the rock and freezes, it expands, exerting tremendous force. This breaks the rock into smaller pieces.

Plant roots give off carbon dioxide gas which combines with water in the soil to form an acid. This acid dissolves certain kinds of rock, particularly limestone and marble, leaving small particles that are not dissolved by the acid. This is a chemical action that helps form soil.

What Is Soil Made Of?

Another component of soil is organic matter or humus. This is material that was once living, such as plants, animals, and insects. As these die, they are acted on by other organisms in the soil such as bacteria, fungi, and earthworms. The material decomposes, and is mixed with the soil to provide nutrients for other living organisms. The fertility of a particular soil is largely determined by the amount of organic matter it contains.

Soil also contains air and water. Between the soil particles are tiny spaces. The

size of these spaces is determined by the size of the soil particles. Generally, the larger the particle size, the larger the pore spaces. These spaces can be filled with air or water and nutrients that plants need for growth. Most plants require that a soil drains well. This means that the pore spaces are large enough that water can move through them easily. If the pore spaces are too small, as in clay, plants will drown because the soil holds water too long. If the pore spaces are too large, as in sand, water drains out of the soil too fast. If the pore spaces are the right size, water can move through the soil, both downward and upward. This movement is called capillary action. Due to capillary action plant roots can use water that is below them as well as water nearer the surface.

Soils are usually comprised of a combination of three different sized particles: sand, the largest; silt; and clay, the smallest. Sand particles are gritty and can be seen with the naked eye. Silt particles feel smooth like flour. Clay particles cannot be seen with the naked eye and, when wet, feel sticky to the touch.

Types of Soils

Soils can be classified according to the percentage of each size particle they contain. This is done by determining the soil texture. Soils can be classified as sand, sandy clay, sandy loam, loam, loamy sand, clay loam, etc.

The soil type determines what kind of crop will do best. For example, rice prefers a clay soil; one that holds water well. Peanuts prefer a sandy soil; one that drains well and allows the peanut, which grows underground, to develop. Most agricultural crops such as cotton, corn, wheat, and grain sorghum prefer a well drained soil. A well drained soil is one that holds enough water in its pore spaces to be available to the plant roots until the next rain, but not so much that water stands at the surface for an extended time.

Importance of Soil

We depend on the soil to grow our food and much of the fiber that we use for clothing. Erosion can cause a farmer or rancher to lose his most valuable asset: his soil. Erosion is the movement of soil from one place to another by wind or water. When the wind blows across bare, unprotected soil it picks up soil particles and blows them away. As the wind becomes stronger it can pick up larger and larger particles, finally leaving only hard-packed subsoil that is unproductive for growing plants. The soil that is blown away is deposited in other areas, sometimes miles away, and can actually become so deep that it smothers other plants. During the Dust Bowl of the 1920s many farmers lost their farms because the soil either blew away or was covered by a layer of sand. This was caused by the land being plowed and left without a protective cover of plants.

Water also causes soil to move from one place to another. When heavy rains

fall on sloping, unprotected soil, the water moves downhill, picking up soil particles as it goes. Gullies are cut in the land with the soil particles being deposited at the lower end of the field, or in a stream or river, where they are carried even further away. If this continues the land will become too rough to cultivate and the most productive soil will be lost.

Farmers and ranchers have learned how to protect their soil from wind and winter erosion. One way is to plant a cover crop which protects the soil from being washed or blown away. Another practice farmers use is contour plowing, which means instead of plowing up and down the slope, they plow at right angles to the slope. Farmers also construct terraces that divert the water off the field slowly, in the direction they want it to go. When crops are harvested the stubble is left to provide cover for the soil. Steeply sloped land is not farmed, but instead planted to grass for grazing livestock. The grass keeps the soil covered. This prevents erosion, while at the same time allowing the farmer or rancher to raise cattle, sheep, goats, and other livestock that can convert the grass into meat, milk, and other products used by humans.

In areas where wind erosion is a problem farmers plant wind breaks. These are rows of trees on the side of the field where the strongest winds come from. The trees help slow the speed of the wind so it can't pick up soil particles. Wind erosion can also be controlled by keeping the soil covered with plants during the time of year when the wind is most likely to blow.

Soil erosion has been significantly reduced since the 20s and 30s. It still occurs, but agricultural producers have learned how to control and minimize it.

The United States Department of Agriculture Natural Resources Conservation Service (NRCS) is a federal agency that provides technical assistance to farmers and ranchers helping them control erosion on their land. The NRCS has offices in nearly every county in Texas and provides educational information to educators.

The Texas Soil and Water Conservation Board is a state agency that also assists farmers and ranchers in soil and water conservation.

What Is Soil?

Lesson Plan

1. Introduce new vocabulary:

Grades 1-3	Grades 4-6
Soil	Erosion
Sand	Organic
Silt	Inorganic
Clay	Decompose
Texture	Humus

2. Discuss properties and characteristics of things: how they look, feel, smell.
3. Discuss the composition of soil: Mineral (inorganic), organic matter, air and water.
4. Show examples of inorganic mineral (a rock), organic matter (grass clippings, leaf, grasshopper, cricket), air (an empty cup), and water (a cup with water in it).

   Ask students if these things mixed together form soil. (No, minerals are reduced to small particles, organic matter undergoes decay or decomposition, air and water are found in the spaces between particles.)
5. Cover a desk or table with newspaper. Place samples of good, commercial top soil (this can be obtained in bags from a garden center) on paper plates for students to examine in groups of two or three. Use What Is Soil? Chart to record observations.
   A. Have students separate minerals (inorganic matter) from organic matter.
   B. Have them record their observations including color; identifiable objects such as twigs, leaves etc.; texture (does it feel smooth or gritty).
   C. Have students wet a handful of soil and make a ball. Does the ball stay together of fall apart?
6. Have students examine samples of sand. Play sand works well. Play sand can be obtained at a lumber yard or garden center. Using the same methods as above, compare and contrast the sand and top soil. How much organic matter does the sand have compared to the top soil? How well does the sand make a ball when wet?
7. Have students bring a soil sample from home, or have them collect samples from different areas of the school yard. Compare these samples to the top soil and sand.

8. Have students participate in the game, Oh Where, Oh Where Can the Water Go? To help them get the concept of particle size, pore spaces and water movement in the soil.
9. Have students complete the Water Bottle Activity so they can see how different size particles differ in settling rate.

Additional Resource:

Contact the USDA Natural Resources Conservation Service in your county for additional ideas, activities and speakers who can visit your class.

Additional Activities:

1. Using soil that students collect from their yard, garden, pasture or school grounds, have them follow the Soil Texture-By-Feel Chart to determine the type of soil they have.
2. Conduct experiments to determine which soil type is best suited to plant growth.
    A. Use clear plastic cups as pots.
    B. Drill or punch drain holes in the bottom of each cup.
    C. Fill each cup 3/4 full of soil. Use as many different types as you can find. Pure sand, clay, sandy loam, clay loam, etc. Contact your county Farm Bureau, county agent or ag science teacher for assistance in finding a variety of different soil types.
    D. Plant 2-3 bean seeds, ½"-1" deep, around the outside of each cup. The seeds should be visible through the plastic.
    E. Water each cup until thoroughly moist. Measure the amount of water used and put the same amount on each cup. Keep the soil moist, but always use the same amount of water on each cup.
    F. Record the date seeds were planted on the chart. Record the number of days it takes seeds to germinate.
    G. After seeds germinate measure the root length and shoot length daily, using a metric ruler, and record on Plant Growth Observation chart.
    H. Water every 2-3 days using the same amount of water on each cup.
    I. You can carry this investigation past 14 days, but you may have to transplant the plants to larger pots. Continue measurements of the main stem of each plant.
    J. Write about your observations and conclusions.

What Is Soil?
Observation Chart

	Top Soil	Sand	Student Sample
Color			
Texture (Smooth, sticky, gritty?)			
Organic Matter (Yes, no, some? Twigs, leaves, etc.)			
Does it make a ball? Describe. (Doesn't make ball, makes loose ball, makes tight ball)			

Soil Types

Plant Growth Observation Chart

Date Seeds Planted	Sand					
# Days to germination						
Root length R						Day 1
Shoot length S						
R						Day 2
S						
R						Day 3
S						
R						Day 4
S						
R						Day 5
S						
R						Day 6
S						
R						Day 7
S						
R						Day 8
S						
R						Day 9
S						
R						Day 10
S						
R						Day 11
S						
R						Day 12
S						
R						Day 13
S						
R						Day 14
R						

Where, Oh Where Can the Water Go?

A good way to demonstrate how different sized soil particles affect the way water moves through the soil is to have students be the particles and water.

1. Choose 3-4 students to be “water”.
2. Have the rest of the students be “sand” particles. Have them stand in a group (not in a straight line) with their arms outstretched sideways. Since they are the largest particles they can stand anywhere and be able to rotate around without touching anyone.
3. Have “water” walk through the “sand”.
4. Now have Students stand with hands on hips, elbows touching their neighbors’ elbows. They now represent “silt” or “humus” particles.
5. Have “water” move through the “silt” particles.
6. Now have students stand with arms at their sides with shoulders touching. They represent the smallest particles, “clay”.
7. Have water try to walk through the “clay” particles.
8. Now divide students equally between “sand, silt and clay”.
9. Have “water” walk through now.

Discussion Questions

1. Which soil was it easier for water to pass through? (Sand)
2. Which soil was it most difficult? (Clay)
3. What might happen to plants in pure sand? (Water would move through quickly, drying the sand out and causing the plant to wither and die if water was not continually added.)
4. What would happen to plants in a clay soil? (Water would not be able to move out of the soil so the plants would drown.)
5. What should a soil contain for plants to grow well? (A mixture of particle sizes: sand , silt or humus and clay.)

Water Bottle Activity: Separating Particle Sizes

Objective:

Students will observe that soil is made up of particles of different size using settling.

Materials:

Each student should bring from home a 2 or 3 liter soda bottle, with lid.

Procedure:

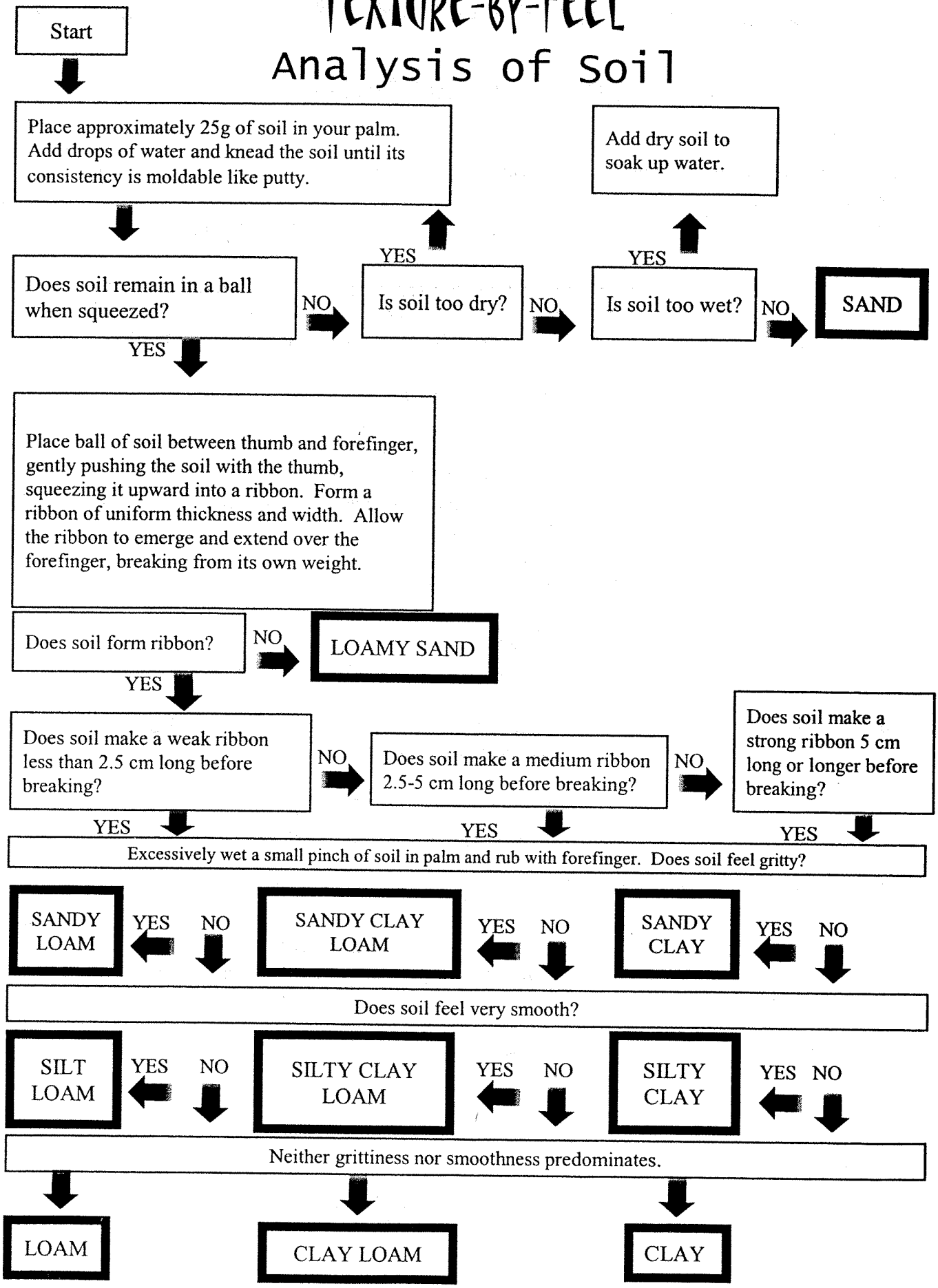
Have students fill their bottles 1/3 full of soil from their yard, garden, pasture, school yard or any other soil they can find. Soil does not have to be from one area but can be a mixture of different soils. Students can make funnels out of paper and pour soil in slowly. They can use a pencil to push stuck material into the bottle. Fill the bottle about 3/4 full of water, screw the lid on and shake bottle vigorously. Place the bottles on a shelf where they can be observed, yet remain undisturbed for several days. Students should observe for several minutes while the soil initially settles, then once a day.

Discussion and Explanation:

The heaviest particles will settle out first. This may be gravel or sand. Clay may remain suspended for several days and may not settle out at all. If there is little or no clay present the water should become clear or nearly so. The students should be able to see different layers that represent the different size particles as they settle out; heaviest at the bottom. Organic matter may float on the surface of the water but will eventually sink.

Have students describe their observations and illustrate the results.

TEXTURE-BY-FEEL
Analysis of Soil



What is Soil? Review

Directions: Fill in the circle under the correct letter.

A	B	C	D	
0	0	0	0	1. The four ingredients which make up soils are

A. Organic matter, air, bugs, & water
B. Organic matter, water, minerals, & air
C. Organic matter, texture, color, & smell

0	0	0	0	2. Organic matter consists of

A. mineral particles
B. stones, sand, & clay
C. dead plant and animal material
D. Sand, silt, & clay

0	0	0	0	3. Mineral particles are composed of

A. sand B. silt
C. clay D. all of the above

0	0	0	0	4. Water and air occupy the area between the mineral particles called

A. holes B. cracks
C. pore spaces D. gaps

0	0	0	0	5. What actually gives soil its texture?

A. roots B. water
C. worms D. mineral particles

ANSWER KEY

What is Soil? Review

1. B
2. C
3. D
4. C
5. D