TEACHING KATE
TEACHING KIDS ABOUT THE ENVIRONMENT

SOIL PROFILE AND PERCOLATION RATE

Grade Level: 8 **Time Required:**

SC Science Standards

This lesson plan was correlated with only the grade level specified unless otherwise noted.

I. A. 1. b. 2
I. A. 1. c. 1
I. A. 1. d. 1
I. A. 2 e, f, h
I. A. 3. a
I. A. 7. a, b

Note: Meets these core standards for 7th: III. A. 2. b and III. A. 3. c.

Purpose

Student will in a classroom and an outdoor setting learn about physical properties of soil and factors that affect moisture retention. They will collect observe and describe soils from near their homes.

Skills

Classifying, communicating, drawing conclusions, identifying variables, inferring, interpreting data, observing.

Concepts

Factors that affect color of soil, effect of the three particle sizes of soil on texture and water retention.

Materials Needed

Soil Samples (sand, loam, clay, silt)	Calgon Dispersing Solution
Stopwatch Or Clock With Second Hand	1" Diameter Plastic Tubing, 5" long
Large Beakers (1 per group)	Magnetic Stirrer
100 ml. Graduated Cylinders	Distilled Water
U. S. Standard Soil Sieves	Balance
Vials With Lids	Stirring Rod
Ring Stands	Small Beakers
Cheese Cloth	Rubber Bands
5% HCl	Eye Droppers

Definition of Terms

Aerate	To expose to air.
Bedrock	The solid rock found under soil.
Horizon A	Mixture of humus and coarse sediment.
Horizon B	Fine particles such as clay, material leached from Horizon A and some plant roots.
Horizon C	Weathered bedrock and precipitated soluble materials.
Horizon O	Organic matter on top of the uppermost layer of soil.
Humus	Materials formed from decayed organic matter found just above and incorporated into the topsoil.
Leaching	A process by which some soil components are dissolved and carried downward by water.
Residual	Soils that form in place by the gradual weathering of parent rock.
Soil	A mixture of weathered rock and decayed organic material.
Soil Profile	A vertical section of all horizons that make up a soil. (3 distinct layers.)
Texture	The granular composition of soil.

Transported Soil — Soil that has been removed from one area by erosion and deposited in another location.

Before the Session

Select several places where these sessions will be taught. One area should be in the classroom, another in sandy area and the last in an area where grass is plentiful and growing. Choices will depend on locale. Use a drying oven to dry soil samples.

Background Information

Soil covers most land surfaces. To a farmer, soil is material in which plants will grow. To an engineer, soil is any unconsolidated material. To an earth scientist, soil is a weathered zone of rocks to which organic materials have been added.

Soil is the support for life on earth. It is composed of a mixture of mineral ingredients (rock, clay, silt and sand), organic ingredients (living organisms and decomposing organic matter), moisture and air spaces. Soil must be protected by contour plowing and maintenance of vegetative cover. This is because when topsoil erodes the remaining clay and bedrock cannot support vegetation.

Classification of soil by texture may be determined by the amount of clay, silt and sand contained in the soil. Texture refers to the granular composition of the soil. Loam is a mix of the three.
Soil particles are classified by the United States Department of Agriculture as follows:

Very coarse sand (2.0-1.0 mm)
Coarse sand (1.0-0.5 mm)
Medium sand (0.50-0.25 mm)
Fine sand (0.25-0.10 mm)
Very fine sand (0.10-0.05 mm)
Silt (0.05-0.0002 mm)
Clay (<0.0002 mm)

Sand particles feel gritty when soil is rubbed between the fingers. They are not plastic or sticky when wet. Silt feels smooth and powdery when rubbed between fingers. It is not plastic or sticky when wet. Clay feels smooth, sticky and plastic when wet. It forms hard clods when dry.

Texture is a very important characteristic of the soil. It effects the chemical, physical and biological properties of the soil.

The following is a guide to the feel of each class of soil texture:

Sand	Loose and single-grained if squeezed in the hand when dry it will fall apart when the pressure is released. Moist sand will form a cast but will crumble when touched.
Loamy Sand	Has characteristics of sand but will make casts that are slightly more stable.
Sandy Loam	Contains sand but has enough silt and clay to make it somewhat cohesive. Squeezed while dry it makes a cast that easily falls apart, but when moist it will not break apart if carefully handled.
Loam	Relatively evenly mixed with sand, silt and clay. It feels smooth and slightly plastic yet somewhat gritty. A squeeze tested dry cast holds together if handled carefully, but wet it can be handled quite freely.
Silt Loam	Contains mostly silt with a moderate amount of the fine grades of sand and a small amount of clay. When dry it appears quite cloddy and lumps can be easily broken off. If pulverized it feels floury. When wet it will run together and puddle. Silt loam will form a cast dry or wet. When given the squeeze test it will not ribbon but will give a broken appearance.
Clay Loam	Fine textured, it breaks into clods or lumps that are hard when dry. Moist soil which is pinched between a finger and thumb will form a thin ribbon which barely sustains its own weight and breaks easily. When moist it is plastic and will form a cast that will bear much handling.
Sandy Clay Loam	Soil that is similar to clay loam but is distinctly gritty.
Silty Clay Loam	Similar to clay loam but with a velvety feel when wet.
Clay	Fine textured, it forms very hard clods when dry and is very plastic and sticky when wet. The ribbon test forms a long flexible ribbon.
Sandy Clay	Soil similar to clay but wit a gritty feel.

Suggested Lesson Plan

Motivation

1. Discuss soil, soil structure and soil composition with students.

2. Provide a vial of soil for each group of 2 students. Have students study samples of soil with a magnifying glass.

3. As students examine the soil ask them to look for materials that they recognize. As the students find these materials have them record them on the chart to use later. Some material found could include sand grains, clay, fragments of plants (humus), flakes of mica, plant roots, insects and perhaps evidence of iron stain.

4. After the examination has been completed, put a drop of 5% HCl on each group of students' sample to test for carbonate minerals. Discuss with the students the possible origin of the materials in the soil. (Provide any information needed for sufficient understanding.)

Part 1

Analysis of Particle Size

1. Settling Time

    a. Weigh out 100 grams of soil. Fill a large beaker with distilled water and add 10 ml of Calgon dispersing solution.

    b. Put beaker on the magnetic mixer, add a large stirring magnet and turn on the mixer so the water is being stirred vigorously. Slowly pour soil into the beaker and mix for 10 minutes.

    c. After the mixing is finished, pour into the 1000 ml graduated cylinder. Add enough distilled water to bring the level up to 1000 ml.

    d. Stir vigorously for one minute with a stirring rod. Stop stirring and record the time. At 40 seconds measure the amount of soil that has settled on the bottom of the cylinder. This is the sand portion, record it on a data sheet in ml or mm.

    e. Do not disturb the cylinder until next day, then measure the total amount of sand and silt. Subtract the amount of sand and record the amount of silt on the data sheet in ml or mm.

2. Dry Particle Size

    a. Weigh out 100 grams of dry soil.

    b. Prepare a set of sieves in the size sequence 5, 7, 9, 24, 48, 60 and 250.

    c. Pour the dry soil into the sieve series starting with the largest mesh. Shake the sieves over a pan to make the soil settle to the smallest sieve possible. Break up any larger particles as needed.

    d. Lay out a series of paper towels and label each with mesh size of one of the screens. Also, label one for the pan.

    e. Pour soil from each sieve and the pan on appropriate towels.

    f. Weigh a paper towel and record the weight in grams. Weigh each size sample, subtract weight of paper towel and record on Table 1. When totaled, the samples should add up to 100 grams.

3. Wet Particle Size

    a. Obtain a vial with a lid to match.

    b. Fill the vial half full with soil.

    c. Add distilled water to fill vial.

    d. Seal tightly and shake vigorously for 1 minute. Add more water if volume in vial has been reduced due to the filling in of spaces previously occupied by air within the soil sample.

    e. Allow vial to stand for one hour.

    f. Sketch the contents and label.

<u>Part 2</u>

<u>Soil Texture by Feel</u>

1. Using the soil provided, determine whether the soil best fits into a clay, clay loam or sand class.

2. Have students place about 1/2 to 1 teaspoon of soil in their hands.

3. Add water very slowly, drop by drop, from an eye dropper.

4. Knead the soil while adding water and bring to the consistency of moist workable putty.

5. When the soil is at the proper consistency, try to press into a ribbon between thumb and forefinger.

6. Record results in Table 2.

Part 3

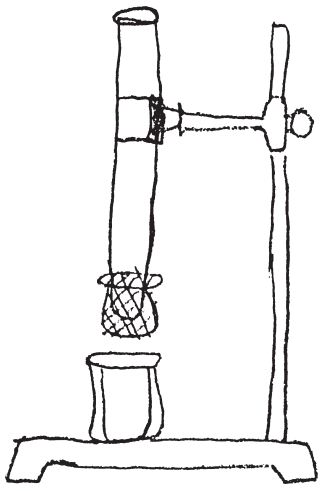
Soil Percolation Rate

1. Prepare a ring stand as shown in diagram. Use a rubber band to attach a piece of cheese cloth to one end of the hard plastic tube. Attach the tube to the ring stand so that the end with the cheese cloth is pointed downward. Place a beaker under the tube.

2. Add 100 mm of soil, packing it lightly to make up the 100 mm.

3. Add 100 ml of tap water and note the time. After 30 minutes, remove the small beaker from under the tubing.

4. Measure the amount of water collected in the beaker and subtract from the original 100 ml. This will determine the amount of water retained in the soil.



5. Record results in Table 3.

Part 4

Discussion and Summery of Results

1. Within groups, classify each soil based on collected data. Record in Table 4.

2. Answer questions on Worksheet 3.

3. Hand in tables and answers to questions.

Extension

This unit on soil will give the student a sense of the importance of soil. With the use of discovery oriented laboratory activities, field activities and guest speakers, students will develop a holistic view of soil.

The fact of the matter is that soil is taken for granted. No it is not, just dirt, even though its properties and characteristics, how it forms and its importance are bothused and abused.

There are people (you and I and billions more), who depend on agriculture, ranching, forestry and numerous other occupations which rely on soil. It needs to be understood that when soil is degraded or eroded at a rate faster than it can be reclaimed or formed, soil must be considered a non-renewable resource, at least locally. As individuals, students need to help promote and participate in soil conservation practices.

Ask the local Soil Conservation Agent to visit the class and sample several areas around the school with a soil auger. Students will be able to experience the texture, smell, ribbon and color tests performed in the field. These may be used to classify the soil in the area. Discuss soil retention and what has happened in some areas (ex. erosion, compaction). Record information on Worksheet 4.

Resources Available

Earth Science. 1989. D. T. Hesser and S. S. Leach. Merrill Publishing Company.

Elements of Ecology, 3rd edition. 1990. R. L. Smith. Harper Collins Publishers.

Environmental Education Activity Guide. 1993. American Forest Foundation.

Environmental Science: A Framework for Decision Making. 1989. D. Chiras. Addison-Wesley Publishing Company.

Soil Conservation Service.

Soil survey of the county where school is located.

Teaching KATE. 1994. Coalition for Natural Resource Education.

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WORKSHEET 1 — TABLES 1 and 2

Name: Date:

TABLE 1 — Dry Particle Size

Sieve Size	Sample Weight		Weight of Paper		Soil Weight
5	_____	-	_____	=	_____
7	_____	-	_____	=	_____
9	_____	-	_____	=	_____
24	_____	-	_____	=	_____
48	_____	-	_____	=	_____
60	_____	-	_____	=	_____
250	_____	-	_____	=	_____
Pan	_____	-	_____	=	_____
Total					_____

Soil Source _____

TABLE 2 — Soil Texture By Feel

Soil Sample Number	Soil Type
1	_____
2	_____
3	_____
4	_____

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WORKSHEET 2 — TABLES 3 and 4

Name: Date:

TABLE 3 — Soil Percolation Rate

Soil Sample Number	Percolation Time	Total Water Added	Water Recovered	Water Retained
1	30 min.	100 ml		
2	30 min.	100 ml		
3	30 min.	100 ml		
4	30 min.	100 ml		

TABLE 4 — Summary of Results

Classification	Location
1.	
2.	
3.	
4.	

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WORKSHEET 3

Name: Date:

I. What is the relationship between particle size and percolation rate?

II. What does particle size have to do with the retention of water in the soil?

III. Which soil had the most even distribution of particle sizes?

IV. Which soil had the most uneven distribution of particle sizes?

V. What size particle sinks in water most slowly?

VI. What size particles would travel farthest in moving water such as a river?

VII. On a steep slope, what size particle would wash away most easily?

VIII. As a result, how would you describe mountain soils based on particle size?

IX. Beach sand in a given area tends to be composed of particles very nearly equal in size. Suggest a reason for this.

X. In Upper Newport Bay, flood waters containing soil flow rapidly into the upper part of the bay. They then slow down as they spread out over a large flat expanse of water. Farther down the bay, these flood waters move very slowly into channels where there are homes and boat slips. Describe the likely particle size of the materials on the bottom of these channels.

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WORKSHEET 3 — Teacher's Guide

Name: Date:

I. What is the relationship between particle size and percolation rate? **The larger the particles, the greater the percolation rate.**

II. What does particle size have to do with the retention of water in the soil? **The larger the particles size, the lower the water retention.**

III. Which soil had the most even distribution of particle sizes? **(Depends on the type of soils brought into the class.)**

IV. Which soil had the most uneven distribution of particle sizes? **(Same as 3.)**

V. What size particle sinks in water most slowly? **Clay.**

VI. What size particles would travel farthest in moving water such as a river? **Clay.**

VII. On a steep slope, what size particle would wash away most easily? **Clay.**

VIII. As a result, how would you describe mountain soils based on particle size? **Mountain soils are often made of the largest particles.**

IX. Beach sand in a given area tends to be composed of particles very nearly equal in size. Suggest a reason for this. **It is eroded from inland regions and larger particles drop out first.**

X. In Upper Newport Bay, flood waters containing soil flow rapidly into the upper part of the bay. They then slow down as they spread out over a large flat expanse of water. Farther down the bay, these flood waters move very slowly into channels where there are homes and boat slips. Describe the likely particle size of the materials on the bottom of these channels. **Large particles would be deposited first in the bay. In the channels, clay would probably be found.**

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WORKSHEET 4

Name: Date:

Soil Horizons: Describe the properties of each.

I. Horizon O
   A. Site 1-
   B. Site 2-
   C. Site 3-

II. Horizon A
   A. Site 1-
   B. Site 2-
   C. Site 3-

III. Horizon B
   A. Site 1-
   B. Site 2-
   C. Site 3-

IV. Horizon C
   A. Site 1-
   B. Site 2-
   C. Site 3-

V. Bedrock
   A. Site 1-
   B. Site 2-
   C. Site 3-

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TABLE TO USE FOR SOIL CHARACTERISTICS

Name: Date:

Color	Indicates
Dark Brown	Well Drained
Red	Well Drained
Pale Color	Top Soil Removed
Mottled	Waterlogged
Grey With Yellow, Red, Blue, or Green	Poorly Drained
Black	Organic Matter Present

Texture	Indicates
Gritty	Sandy
Flourlike	Silty
Sticky	Clay