TEACHING KATE
TEACHING KIDS ABOUT THE ENVIRONMENT

MINI-UNIT ON SOIL TEXTURE

Grade Level: 10 **Time Required: 4 class periods of 60 minutes each**

SC Science Standards

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

Grades 9-12:
I. B. 1, 2, 4, 9
I. C. 3
I. D. 1
Note: Meets these core standards for 7th: III. A. 2. b, d; III. A. 3., b, c

Purpose

Students will compare soil texture based on physical characteristics of soil particles. Physical characteristics to be observed and tested include size, texture, air space, water availability and permeability. The relationship of soil texture will also be explored.

Skills

Analyzing, application, classification, comparison, concluding, decision making, description, discussion, identification of attributes and relationships, interpretation, measurement, observation, prediction, problem solving, recording and reporting data, verification.

Concepts

Soil differs in its texture and characteristics, soil texture determines water availability and permeability, land use and management are influenced by soil texture.

Materials Needed

Per Group

1 Dry Soil Sample (Collected)	3 Dry Soil Samples (Created)
Calgon Dispersing Solution	3 400 ml Beakers
1 Tall, Thin Jar With Lid	1 Ruler
1 Stopwatch	1 Hand Lens
1 100 ml Graduated Cylinder	Water
Procedure Sheet	Scales (Shared By Class)
Data Sheet (Each Student)	Pre-Lab Worksheet (Each Student)

Definition of Terms

Loam	A soil comprised of a mixture of sand, silt and clay.
Percolation (“Perc” Test)	Test used to determine the rapidity with which water will move into and through a soil sample.
Permeability	The rate at which water moves through soil.
Soil	Naturally occurring mixture of minerals, organic matter, water and air which has a definite structure and composition and forms on the surface of land.
Soil Particles	(AKA: Soil Separates) Those materials which may be found as components in a soil sample such as sand, silt and clay.
Soil Texture	The physical property of the soil as a result of the relative proportion of the soil particles present in a soil sample.
Textural Analysis	Test used to determine the texture of a soil sample.

Before the Session

Review definitions and background information. Have Pre-Lab Worksheet, procedure sheets and data sheets copied and ready to distribute. Assemble equipment- may wish to do so in groups. Have available enough previously collected soil samples for each group to have a different sample. Create three soil samples using pottery clay and play sand. Be sure to make enough of each soil sample type for every group to have one cup of each. Type Awill be 3 parts sand to 1 part clay. Type

B will be 1 to 1. Type C will be 1 part sand to 3 parts clay. You may wish to complete a trial of the entire activity prior to student interaction. This will provide a working knowledge of the procedures and pitfalls and provide sample data for the soils to be used.

Background Information

Table 1. Soil Particle Characteristics

Particle	Size (mm)	Feel	Fertility	Air Space	Water Availability
Sandy	2.0-.05	Gritty	Low	Fewer, Large	Low
Silt	.05-.002	Smooth	Medium	Some, Small	Good
Clay	<.002	Sticky	High	Many, Tiny	Good, Slow Movement of H_20

Table 1 reflects much of the information on soil particles which comprise soil and constitute its texture. Sand, being the largest and coarsest of the particles, creates fewer but larger air spaces in soil. Due to these air spaces, sandy soils usually percolate quickly, drain quickly and hold very little water. They have low fertility due to the low availability of water and their low nutrient levels. Sandy soils feel and sound gritty. Sand particles can be easily seen by the naked eye. Silt can barely be seen by the naked eye. It feels soft and smooth with a flour-like texture. Silt is a medium sized particle with more but smaller air spaces than sand. These air spaces allow for good water availability and fertility. Clay is the smallest of the particles and can not be seen even when using an ordinary microscope. The particles are multilayered and contain many elements. Clay soils are sticky in nature and make a ribbon when rubbed between two fingers. There are many tiny air spaces between the clay particles. The smallness of the spaces causes clay soils to percolate slowly or not at all. Over saturated clay soils will not percolate at all. While the pore spaces in clay soils are tiny, the total amount of pore space is greater than in any of the other particles types. Clay soils can hold a large quantity of water. Because clay soils can hold water quite well, allow only slow water movement and contain many elements necessary for plant growth, they are high in fertility. Soils can be comprised of any one, two or three of these soil particle types in any combination to give it texture. Soils are usually classified by texture.

Texture can be determined by textural analysis. The procedure for textural analysis is easy and is given in the student procedure sheet. The method of testing given is not as scientifically accurate as the method which uses a hydrometer to measure the specific gravity of the sample at various time intervals. The hydrometer method may be found in an ecology or environmental study laboratory manual and could be substituted for the method given in the procedures section of this activity if desired. Once the procedure for textural analysis is complete, the Soil Texture Triangle can be use

to determine the texture type of the soil sample. The soil texture triangle and directions for its use are found in the student procedure page.

Soil texture is directly related to the percolation rate of a soil in the size of air spaces and surface area of the soil particles. For example, sand is the largest of the soil particles therefore, it has the largest surface area of the soil particles. Percolation is usually quick in sandy soils. The faster the percolation rate, the more permeable the soil (generally). Rate of percolation deterines how land can be used. Soils with slow percolation rates would be difficult to drain causing problems with a septic system. Alterations in a septic system or actual land use would be required.

Suggested Lesson Plan

Day 1

1. Facilitate a whole class discussion on common soil textures and their characteristics. May wish to draw the outline of Table 1 given in the Background Information and lead the discussion towards completion of the table. Be certain to discuss why each characteristic is important as related to plant growth. Definitions for key terms such as percolation test, textural analysis, loam, permeability, soil, soil particles and soil texture should be discussed as well. Students should take notes throughout the discussion. (20 minutes.)

2. Divide the students into groups of three or four. Distribute Pre-Lab Worksheets to all students. Have students complete the work sheet cooperatively in their groups. (20 minutes.)

3. Facilitate whole class discussion of the correct answers to the Pre-Lab Worksheet. Have students correct any incorrect answers on their papers. (15 minutes.)

4. Close period by briefly reviewing the soil particles which comprise soil texture and their characteristics. (5 minutes.)

Day 2

1. Briefly review previous day's lesson. (5 minutes.)

2. Have students return to their groups. Distribute all materials. Briefly run through the procedures sheet giving any last minute instructions, reminders and cautions. Review procedures for scale use. Students must finish numbers I-V of the Procedure Sheet for Soil Investigation. These procedures correspond with questions A1-9 and B1-5 on the data sheet. Numbers VI-X of the procedures must also be completed today. These procedures correspond with questions C1 and C2 of the data sheet. (45 minutes total for instructions and activity.)

3. Review clean up procedures and have students clean up. (10 minutes.)

Day 3

1. Review activity parts completed on previous day. Have students reform groups. (5 minutes.)

2. Complete numbers XI-XXI of the procedures which correspond with questions C3-D3. (50 minutes.)

3. Review clean up procedures and have students clean up. (5 minutes.)

Day 4

1. Review activity parts completed on previous day. Have students reform groups. (5 minutes.)

2. Complete procedure XXII which corresponds to questions E1-4 and the data sheet. (35 minutes.)

3. Collect, correct and grade all data sheets as a means to evaluate mastery of mini-unit purposes and concepts. (5 minutes.)

4. Facilitate whole class discussion of entire activity to bring closure to the mini-unit. (15 minutes.)

NOTE

Be sure to monitor the groups throughout the activity to provide assistance and support to the students as necessary.

Application

It is vital that students understand why and how a soil will react in given situations since soil can affect land use and management through its characteristics and texture. A soil's permeability and percolation should be considered when purchasing, using and managing land for agriculture, construction and recreational purposes. Can you farm with low sol permeability? Should you build a home with a septic tank on land that does not percolate? Will this forest produce plants that attract wildlife for hunting based on its soil texture? These are questions students should be able to ask and answer that relate to "real" life.

Resources Available

Elements of Ecology, 3rd edition. 1992. R. L. Smith. Harper Collins, New York.

Project Learning Tree, Activity 70 “Soil Stories.” 1993. American Forest Foundation. pp. 252-257.

Teaching KATE. 1994. Coalition for Natural Resource Education.

WOW!: The Wonders of Wetlands, “How Thirsty is the Ground.” 1991. B. E. Slattery. Environmental Concern, Inc. p. 115.

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MINI-UNIT ON SOIL TEXTURE

PRE-LAB WORKSHEET — SOIL INVESTIGATIONS ACTIVITY

Name: Date:

I. What do plants get from soil?

II. Do plants have different soil requirements?

III. Why are air spaces in the soil important?

IV. List the soil particles in order from smallest to largest.

V. What does permeate mean?

VI. What does percolate mean?

VII. Why do you believe soil is important in deciding how to use the land?

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MINI-UNIT ON SOIL TEXTURE

PRE-LAB WORKSHEET — SOIL INVESTIGATIONS ACTIVITY
TEACHER'S GUIDE

Name: Date:

I. What do plants get from soil?

air, H_2O, nutrients, structural support

II. Do plants have different soil requirements?

Yes, some plants need a wet soil or an acid soil, etc.

III. Why are air spaces in the soil important?

To allow for air and water that plants need.

IV. List the soil particles in order from smallest to largest.

(Smallest) clay, silt, sand (Largest)

V. What does permeate mean?

To go into and throughout completely.

VI. What does percolate mean?

To move through.

VII. Why do you believe soil is important in deciding how to use the land?

Because soil is the basic foundation of the land. It determines what will grow, how H_2O will move, etc.

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MINI-UNIT ON SOIL TEXTURE

PROCEDURE SHEETS — SOIL INVESTIGATION ACTIVITY

Name: Date:

I. Answer questions 1-9 under section A of the data sheet.

II. Fill a 400 ml beaker to the 100 ml mark with soil. Be sure the soil is dry and that all clumps are broken up.

III. Weigh the beaker. Record the weight in grams by question 1 under section B of the data sheet.

IV. Tap the side of the beaker against your hand to settle the soil. Pour water into the beaker **SLOWLY** until it reaches the top of the soil. Be sure that all of the soil is wet and the water comes to the soil surface. This may take some time so be patient. Reweigh the beaker and record the weight in grams by B2 on the data sheet.

V. Answer questions B3-5.

VI. Answer question C1.

VII. Transfer the soil and water from the beaker to the jar. Be careful not to spill any during the transfer.

VIII. Add 2 ml of Calgon dispersing solution to 200 ml of water and mix. Add water with dispersing solution to the jar until the soil is covered with approximately 5.0 cm of water. Add the water to the jar **SLOWLY.**

IX. Allow the soil to settle for 15-30 minutes. Measure the height of the soil in the jar in mm. Record the height by C2. (Note: Clay particles will be in suspension during/after the transfer and will take days to completely settle. The measured soil height will, therefore, be slightly inaccurate.)

X. Put the lid on the jar tightly. Shake the jar vigorously for approximately 2 minutes. Put the shaken jar aside out of the way. Allow the jar to settle for at least 24 hours.

PROCEDURE SHEETS — SOIL INVESTIGATION ACTIVITY CONTINUED

XI. Design your data table for question C3.

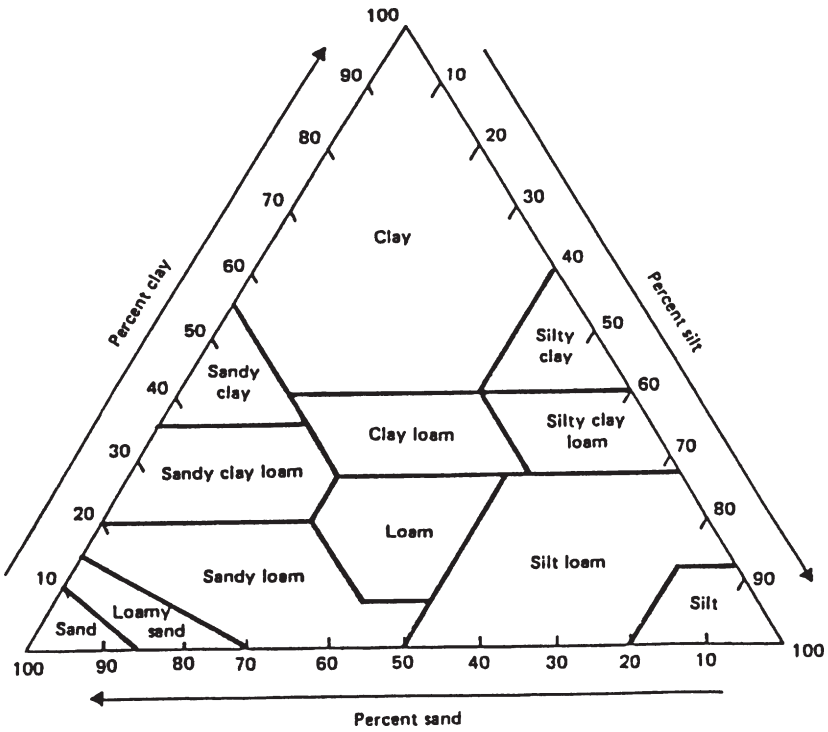
XII. Look at the settled soil particle layers in the jar. Be careful not to disturb the layers. Measure the height of each layer in mm and record the measurements in your data table.

XIII. Complete the rest of the data table. To determine the percentage of the soil sample layers use this formula:

$$\frac{\textit{Height of Settled Layer}}{\textit{Height of Soil Originally}} \times 100$$

XIV. Complete question C4.

XV. Use the following soil texture triangle to determine your soil sample's type.



To use the triangle, locate the percentage of each particle. Draw a straight line **(in PENCIL)** through each point. Where the three lines intersect is the name of your soil type. You have completed textural analysis. Be sure to erase the lines when you are finished.

PROCEDURE SHEETS — SOIL INVESTIGATION ACTIVITY CONTINUED

XVI. Complete questions C5 and C6.

XVII. Complete question D1 and design your data table for question D2.

XVIII. Label one 400 ml beaker "A", one "B", and one "C". Fill each beaker with the soil sample which corresponds to the letter on the beaker.

XIX. Pour approximately 30 ml of water into each beaker at the **SAME** time. Begin the stop-watch as soon as the water is poured.

XX. Time exactly how long it takes for the water in each beaker to reach the bottom. Record those times in your data table in D2. You have completed a percolation or "perc" test.

XXI. Answer question D3.

XXII. Read the following soil mysteries. Discuss them with your group. Answer questions E1-4.

Soil Mystery 1

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 permits and having the site tested for a septic system by having a percolation ("perc") test done.

When they received the test results, their hearts sank. The soil on the property had failed the perc test, and they would not be able to build their dream house. Why not? What was wrong with the soil.

Soil Mystery 2

A mudslide destroys homes. What soil conditions caused this to happen?

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DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY

Name: Date:

Answer the following questions on your own paper in complete sentences. Don't forget to put the names of your group members on it.

A. Describe where the soil is from.

1. Where was your soil site. Use words or draw a picture.

2. What was growing on this site?

3. Was it level or on a slope?

4. What other things did you notice?

Describe the soil.

5. What color is it?

6. How does is smell?

7. How does it feel? Roll some in your fingers.

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY CONTINUED

Name: Date:

8. What do the largest soil particles look like? The smallest?

9. How does your sample compare to the other soil samples?

B. Describe the air space.

1. How much does the container with 100 ml of soil in it weigh?

2. How much does the container with water to the top of the soil weigh?

3. What is the weight of the water added to the container?

4. What is the volume of air in this soil sample? Note: 1 gram of water displaces 1 milliliter of air.

5. Which soil sample has the greatest amount of air space?

C. Describe what is in your soil.

1. Based upon your previous observations and knowledge, formulate a hypothesis about how the soil will settle into layers.

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY CONTINUED

Name: Date:

2. What is the height of the soil in the jar before adding water?

3. Design and complete a data table detailing the particle type, height, color and percentage of soil sample layers.

4. What are the components of your soil sample after they have settled in the jar? Draw what the layers look like.

5. Determine what type of soil your sample is by using the soil texture triangle.

6. How do they compare to the other samples?

D. Describe percolation.

1. Based on your previous observations and knowledge, formulate a hypothesis about which soil sample will percolate fastest nd which will be slowest.

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY CONTINUED

Name: Date:

2. Design and complete a data table detailing the soil samples and the time in minutes of complete percolation.

   Note: Sample A = 3 parts Sand + 1 part Clay
   Sample B = 1 part Sand + 1 part Clay
   Sample C = 1 part Sand + 3 parts Clay

3. Explain your results.

E. Solve the mysteries.

1. Describe the problem in soil mystery 1.

2. Describe a possible solution for the problem in soil mystery 1.

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY CONTINUED

Name: Date:

3. Describe the problem in soil mystery 2.

4. Describe a possible solution for the problem in soil mystery 2.

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MINI-UNIT ON SOIL TEXTURE

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY
TEACHER'S GUIDE

Name: Date:

Answer the following questions on your own paper in complete sentences. Don't forget to put the names of your group members on it.

A. Describe where the soil is from.

1. Where was your soil site. Use words or draw a picture.

   Student Observation

2. What was growing on this site?

   Student Observation

3. Was it level or on a slope?

   Student Observation

4. What other things did you notice?

   Student Observation

Describe the soil.

5. What color is it?

   Student Observation

6. How does is smell?

   Student Observation

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY
TEACHER'S GUIDE CONTINUED

Name: Date:

7. How does it feel? Roll some in your fingers.

   Student Observation

8. What do the largest soil particles look like? The smallest?

   Student Observation

9. How does your sample compare to the other soil samples?

   Student Observation

B. Describe the air space.

1. How much does the container with 100 ml of soil in it weigh?

   Student Observation

2. How much does the container with water to the top of the soil weigh?

   Student Observation

3. What is the weight of the water added to the container?

   Student Observation

4. What is the volume of air in this soil sample? Note: 1 gram of water displaces 1 milliliter of air.

   Student Observation

5. Which soil sample has the greatest amount of air space?

   Should be clay soil.

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY
TEACHER'S GUIDE CONTINUED

Name: Date:

C. Describe what is in your soil.

1. Based upon your previous observations and knowledge, formulate a hypothesis about how the soil will settle into layers.

   (Bottom) pebbles, sand, silt, clay (Top)

2. What is the height of the soil in the jar before adding water?

   Student Observation

3. Design and complete a data table detailing the particle type, height, color and percentage of soil sample layers.

Particle Type	Height in mm	Color	Percentage of Layer
Sand			
Silt			
Clay			

4. What are the components of your soil sample after they have settled in the jar? Draw what the layers look like.

Student Observations

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY
TEACHER'S GUIDE CONTINUED

Name: Date:

5. Determine what type of soil your sample is by using the soil texture triangle.

   Student Observations

6. How do they compare to the other samples?

   Student Observation

D. Describe percolation.

1. Based on your previous observations and knowledge, formulate a hypothesis about which soil sample will percolate fastest and which will be slowest.

   Fastest A, Slowest C

2. Design and complete a data table detailing the soil samples and the time in minutes of complete percolation.
   Note: Sample A = 3 parts Sand + 1 part Clay
   Sample B = 1 part Sand + 1 part Clay
   Sample C = 1 part Sand + 3 parts Clay

Sample	Composition	Percolation Time
A		
B		
C		

3. Explain your results.

   Sample A should be fastest because it has most sand and least clay. Sand allows rapid H_2O movement.

DATA SHEETS — SOIL INVESTIGATIONS ACTIVITY
TEACHER'S GUIDE CONTINUED

Name: Date:

E. Solve the mysteries.

1. Describe the problem in soil mystery 1.

Doesn't drain H_2O well.

2. Describe a possible solution for the problem in soil mystery 1.

Build a cesspool to hold waste H_2O.

3. Describe the problem in soil mystery 2.

Soils of different textures can cause moisture buildup and cause landslides.

4. Describe a possible solution for the problem in soil mystery 2.

Don't build in such an area.