UTAH Nature Explorers

Time:
(2) 45 minutes classroom sessions

Level:
Secondary Science –Plant and Soil Science 1

Goals:
This lesson will give students a hands-on experience with various soils which will help them more fully understand the concepts of soil textures and structures.

Objectives:
After completing this unit of instruction, students will be able to:

1. Describe the concept of soil texture and its importance

2. Determine the texture of a soil sample

3. Describe soil structure, its formation, and importance

4. Identify various soil structures

Materials listed with each individual activity.

Soil Investigations

by Hailey Haslam, Neicca Butts, and Mark Larese-Casanova

Correlations to Core Curriculum:
Secondary Science -- Plant and Soil Science 1

- Standard 3: Students will explain the history, importance, and scope of plant science.
    - Objective 3: Identify career opportunities in plant science.
        - Indicator d: Describe soil texture and structure.

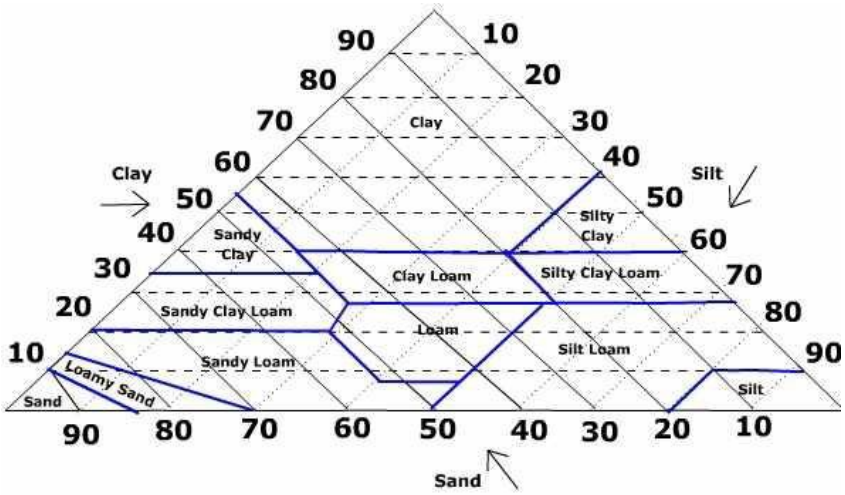
Background Information:

Soil texture is the fineness or coarseness of a soil. It describes the proportion of three sizes of soil particles. These are:
1. Sand—large particle
2. Silt—medium-sized particle
3. Clay—small particle

Soil texture is important because of its effect on the following factors :
1. Water-holding capacity—the ability of a soil to retain water for use by plants
2. Permeability—the ease with which air and water may pass through the soil
3. Soil workability—the ease with which soil may be tilled and the timing of working the soil after a rain
4. Ability of plants to grow—some root crops like carrots and onions will have difficulty growing in a fine-textured soil

Within the 'Soil Textural Triangle,' there are 12 basic textural classes:
a. Silt
b. Silt loam
c. Silty clay loam
d. ***Loam***—contains some of all 3 soil particle sizes
e. Sandy clay loam
f. Loamy sand
g. Sand
h. Sandy loam
i. Sandy clay
j. Clay loam
k. Silty clay
l. Clay

How to read a 'Soil Textural Triangle':



A soil texture triangle is used to classify the texture class of a soil. The sides of the soil texture triangle are scaled for the percentages of sand, silt, and clay. Clay percentages are read from left to right across the triangle (dashed lines). Silt is read from the upper right to lower left (light, dotted lines). Sand from lower right towards the upper left portion of the triangle (bold, solid lines). The boundaries of the soil texture classes are highlighted in blue. The intersection of the three sizes on the triangle give the texture class. For instance, if you have a soil with 20% clay, 60% silt, and 20% sand it falls in the "silt loam" class.
http://www4.uwsp.edu/geo/faculty/ritter/glossary/s_u/soil_texture_triangle.html

Ribbon Method: The relative amounts of sand, silt, and clay may also be determined in the field using the ribbon method. Five textural classes may be determined using the ribbon Method:
a. Fine-textured—a ribbon forms easily and remains long and flexible.
b. Moderately fine-textured—a ribbon forms but breaks into pieces ¾ to 1 inch long.
c. Medium-textured—no ribbon forms. The sample breaks into pieces less than ¾ inch long. The soil feels smooth and talc-like.
d. Moderately coarse-textured—no ribbon forms. The sample feels gritty and lacks smoothness.
e. Coarse-textured—no ribbon forms. The sample is composed almost entirely of gritty material and leaves little or no stain.

Soil structure: Soil structure is the arrangement of the soil particles

Did you know?

Each year, 15 tons of dry soil per acre passes through earthworms. Earthworms eat soil to get the organic materials in it. The rest passes through them.
http://www.doctordirt.com/soilfact/

into clusters or aggregates of various sizes and shapes. Aggregates that occur naturally in the soil are referred to as peds, while clumps of soil caused by tillage are called clods.

Structure is formed in two steps:
1. A clump of soil particles sticks loosely together. These are created through:
    a. Plant roots surrounding the soil and separating clumps
    b. Freezing and thawing of soil
    c. Soil becomes wet and then dries
    d. The soil is tilled
    e. Fungal activity
2. Weak aggregates are cemented to make them distinct and strong. Clay, iron oxides, and organic matter may act as cements. When soil microorganisms break down plant residues, they produce gums that also glue peds together.

Soil structure is important for several reasons:
1. It improves soil tilth.
2. It improves permeability.
3. It resists the beating action of raindrops, minimizing the formation of crusts that reduce crop stands.

There are eight primary types of soil structure. They are:
A. Granular—aggregates are small, non-porous, and strongly held together.
B. Crumb—aggregates are small, porous, and weakly held together.
C. Platy—aggregates are flat or plate-like. Plates overlap, usually causing slow permeability.
D. Prismatic or Columnar—aggregates are prism-like with the vertical axis greater than the horizontal. Prismatic has flat caps while columnar has rounded caps.
E. Blocky—aggregates are block-like, with six or more sides. All three dimensions are about the same.
F. Structureless—there is no apparent structure. It may be found in one of two forms:
1. Single grain—soil particles exist as individuals and do not form aggregates.
2. Massive—soil particles cling together in large uniform masses.

Did you know?

The texture of a soil can indicate the stability, strength, and drainage of a soil, which are important characteristics to know before farming the land, constructing buildings and roads, or installing waste disposal systems.

www.extension.psu.edu/plants/nutrient-management/educational/soil-fertility/some-facts-about-soil-basics

Lessons and Activities:

Day 1 --

Engage (10 minutes) –Show students various samples of soil. One sample should be nearly all sand, one nearly all clay, and one nearly

Materials:

Supplies --

- Lab Packet – Soil Textural Triangle, Texture by Feel, and Soil Sedimentation Test should be printed and stapled together for each student. In addition, you may choose to staple the 'Texture by Feel Flowchart' (link below) to this packet as well to lessen the amount of papers floating around the classroom.
- "Texture by Feel" flowchart (download at http://www.ndhealth.gov/wq/sw/z1_nps/pdf_files/soil_texture_feel_test.pdf)
- 3 soil samples to display to students – one clay, one sand, and one silt
- 36 snack bags filled with various soil samples (to be used for the 'ribbon test')
- Science journals, pencils (1 per student)

Equipment:

- Small whiteboards, dry erase markers, and erasers (1 set per student) *(optional)*
- Class textbook for each student (optional)

all silt. Ask students to determine how the samples differ. Would each sample be equally productive? Indicate that the samples vary according to the size of soil particles. Ask students how particle size might affect various soil properties. Allow comments to lead to a discussion of soil texture.

Explain that the texture of soil is important because it affects water holding capacity, permeability, soil workability, and the ability of plants to grow. For more information on these topics, see the 'background information' section of the lesson plan.

Explore (25 minutes) – Give student their 'Soils Lab Packet.' Tell students that they will be determining the textures of various soil samples during class. The texture can be determined in two different ways. First, the percentage of sand, silt, and clay can be tested in a lab, and then you can determine the texture of the soil using the textural triangle. The second method, in which you determine relative amounts of sand, silt, and clay in the field, is called the ribbon method.

We will first be exploring the textural triangle. *(For information on how to use the textural triangle, see the background information section.)* Explain how to use the 'Soil Textural Triangle,' and do a few practice problems as a class. Make sure your percentages always add up to 100%. When you feel the students are ready to work independently, give the students percentages of sand, silt, and clay (again, making sure percentages add up to 100), and ask them to determine the soil texture using the textural triangle. They can use the textural triangle page in their packet for reference. Have the students do 3-5 problems, or as you feel is needed by your class. After each problem, have students hold a small piece of paper to their chest with their answer so as to help you see where confusion and misconceptions still lie. *(As an alternative, you may choose to have students write their answers down on a piece of paper and turn it in at the end of the lesson.)*

After exploring the textural triangle, tell students that they will now get to try using the ribbon test to determine various soil mediums. This activity should be done in partners.

After assigning partners, have each person come up to the front of the room to get a soil sample. They should also pick up the paper "Texture by Feel" flowchart from the front of the room if it has not already been attached to the lab packet.

Each person should follow the flow chart on their own to conduct the ribbon test. They should write down which soil sample they

Materials:

Supplies –

- Small soil sample with good soil structure (for display)
- 9 Small soil samples, each put into a snack size bag (There should be enough soil in the bag to fill a small jar 1/3 of the way full.)
- Water
- 9 small sheets of newspaper

Equipment--

- 9 small jars with lids
- 9 rulers
- 1 rolls of Masking tape
- 3 Permanent markers
- Soil Pit

believe they have. After each person has completed the ribbon test on their own, partners should work together to do another ribbon test for each of their respective soil samples.

After the ribbon tests have been conducted alone and together, the partnership should together identify what soil sample they have and write it down on their worksheet. If time permits, they should get two new soil samples and repeat this activity with different soil types.

Explain (5 minutes) – In their science journals, have students respond to the prompt, "Why is knowing how to determine soil texture important? What method of determining soil texture do you prefer? Why?"

Elaborate (5 minutes) – Discuss journal entries and address any questions that students may have concerning soil mediums.

If desired, assign the students to read the section of the text on soil structure as homework.

Day 2 –

Engage (10 minutes) – Take a sample of soil with good structure and place it on a tabletop or desktop. Students should be able to see that the soil does not all fall apart. These naturally occurring clusters demonstrate soil structure. Using the background information section above, discuss how soil structure is formed and why it is important for good plant growth.

Briefly discuss the previous day's activities, and review why soil texture is important.

Explore (25 minutes) – Divide students into small groups (approx. 4 people per group) and have them complete the Sedimentation Test of Soil Structure. This should be in their 'Soils Lab Packet.'

While students are waiting 10 minutes before checking their sedimentation jar the second time, invite them to come outside with you to look at a soil pit. Ask them to bring their science journals and a pencil with them. Studying this soil pit will help students understand various soil structures, and where they can be found.

Remind students that granular, crumb, and platy are usually found in the top soil, or A horizon; prismatic, columnar, and blocky are usually found in the subsoil, or B horizon; and that structureless is

usually found in the substratum, or C horizon.

Have students make a scientific drawing and observations about the soil pit in their science journal.

When you go back inside, have students study their sedimentation jar a second time and write their observations on the appropriate lab sheet.

You may choose to have students store their lab packet in their science journal to ensure that they don't lose it before collecting final results from the sedimentation test.

Explain (5 minutes) – In partners, have students discuss what makes a good soil structure, and where various soil structures can be found. After 2-3 minutes of discussion, open this up to a class discussion. Ask students what they noticed about the soil pit today, and how that helped them understand soil structure better.

Elaborate (5 minutes) – If time permits, have students each write a test question for the unit test pertaining to soil texture and structure. Tell students that only a few of their questions will be selected, and those who have their questions selected will get a few points of extra credit on the test.

Assessment:
This 2-day lab is intended to be a part of a larger unit on soil; therefore, no summative assessment has been created for this specific lesson. However, there are many informal assessment opportunities available throughout the lab. If desired, lab packets and journals can be collected so that the teacher can see what the students are still misunderstanding, and what they already understand. In addition, the discussions held at the end of each day focus on the objectives for the lesson plan. The discussion that takes place should give you an indicator of how well your class as a whole understands the topics of soil texture and soil structure.

Extensions:

- Ask students "Why is soil so important?" Allow them to brainstorm ideas, and then watch the following clip from the British Society of Soil: https://www.youtube.com/watch?v=e3Tqbji30UM. The time for the clip is 1:48. After watching the video clip, discuss with students some of the reasons that they learned healthy soil is important.

Did you know?

There are more microorganisms in a handful of soil than there are people on earth!

https://www.quickcrop.ie/blog/2014/01/top-10-interesting-facts-about-soil/

- Have each student collect a small soil sample from their house. During class, allow students to determine what kind of soil is mostly at their house, using the ribbon test. Using that information, have students research what types of plants will grow best in the soil at their house, the advantages and disadvantages of that soil type, and interesting information about their soil. Have each student give a short oral or written presentation discussing what they have learned about the soil type at their house.

Resources:

Books

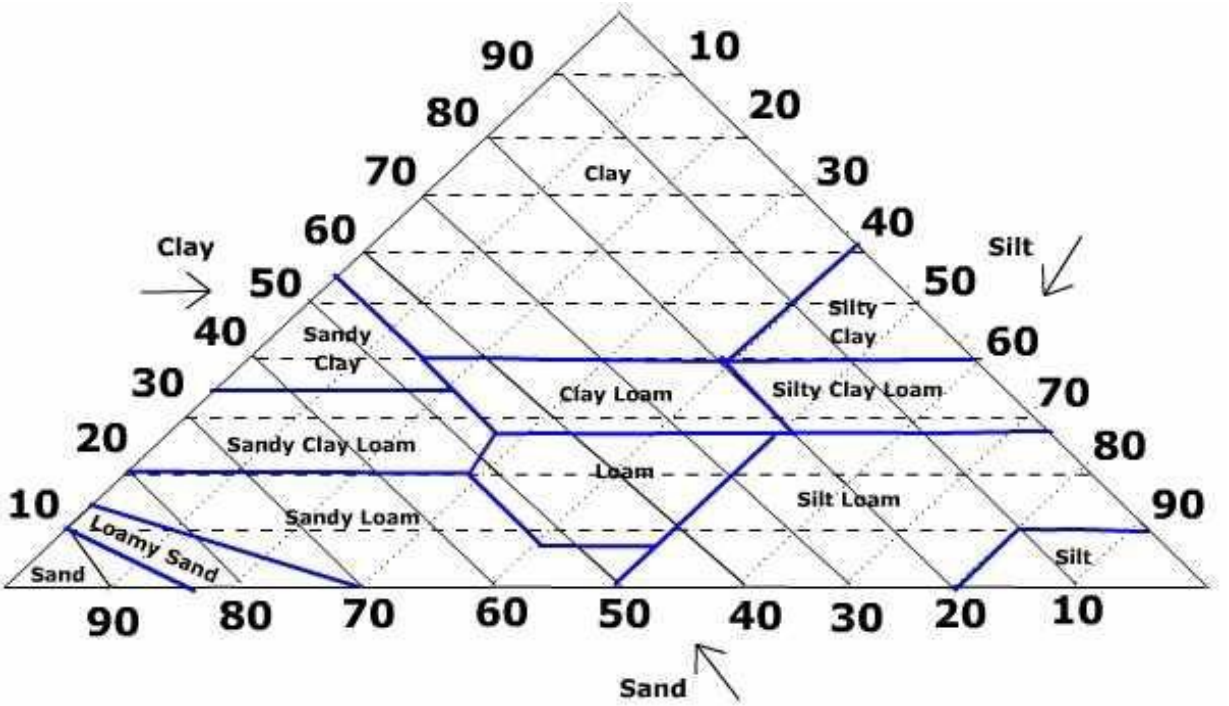
- *Soil Science Simplified* by Helmut Kohnke and D. P. Franzmeier

Websites

- How to read a Textural Soil Triangle -- http://www4.uwsp.edu/geo/faculty/ritter/glossary/s_u/soil_texture_triangle.html
- Texture by Feel flowchart -- http://www.ndhealth.gov/wq/sw/z1_nps/pdf_files/soil_texture_feel_test.pdf
- University of Hawaii: Soil Nutrient Management -- http://www.ctahr.hawaii.edu/mauisoil/a_factor_ts.aspx
- Soil Science Society of America -- https://www.soils.org/
    - Great Article about soil -- http://www.envirothon.org/pdf/CG/Why_Soil_is_Important.pdf

Name_____
Date_____

Soil Textural Triangle Activity



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http://www4.uwsp.edu/geo/faculty/ritter/glossary/s_u/soil_texture_triangle.html

Notes/results for my given soil samples

Texture by Feel – The Ribbon Test

1. Pick up "Texture-By-Feel" from front of room.
2. Follow flow chart and directions as indicated on your flowchart.
3. What type soil sample do you think you have? _____
4. Why do you think that you have that soil type?_____

   _____
5. Have as classmate conduct the test with your soil.
6. Who conducted the texture test? _____
7. What do they think you have? _____
8. Decide together – What soil type do you have? Why? _____

   _____
9. Throw out any spare soil and clean up your desk. Put bag of soil where indicated on board. Wash your hands!

Soil Sedimentation Test

Objective: Determine the soil type based on components of a collected sample

Materials:
Jar with lid Soil Sample Water Ruler
Newspaper Pen/Pencil Masking tape Permanent marker

Initial observations:

1. Identify where you got your soil sample from (*be specific)*: _____
   _____
   _____.

2. Describe your soil sample in the space below. (*be sure to include color, feel, smell, things you see in it, etc.)*

Hypothesis: **Do you think your sample will be mainly sand, silt, clay or organic matter?**
(Remember, a hypothesis is expressed as a statement in a complete sentence)

_____
_____.

Procedure for Setting up the Sedimentation Test

1. Empty the soil you brought in onto a sheet of newspaper on your desk.
2. Make sure you have enough soil to fill your jar 1/3 full with soil. If you don't have enough, notify the teacher.
3. Remove any trash, rocks, sticks, leaves, insects, etc. from your soil sample. Then, place the soil sample in your jar. (*Make sure the lid of your jar has been labeled with your name and today's date using a permanent marker and masking tape.)*
4. Add water to the jar until it is about an inch below the lid.
5. Put the lid on your jar tightly.
6. Shake the jar for 1-2 minutes.
7. Place the jar where indicated (*see note on board)*. DO NOT move each others' jars!
8. After 10 minutes, observe your jar and record the findings in the data table on the back.

We will observe these jars in roughly one week and finish recording the data in the table.

Data for Sedimentation test

Date	Description of what you see	Height of bottom layer	Height of middle layer	Height of top layer

Conclusions (to be completed after analysis after a week of settlement):

1. What was the tallest layer of your sample? _____
2. Did you prove or disprove your hypothesis? _____
3. Did you have any organic matter? _____
4. What did you like most about this lab? Why?

5. What did you like least? Why?