Soil Texture by Measurement

Age: 8-10 years old (grades 3-4), but can be adapted for all youth 5-19 (grades K-12)

Objectives:

1. Members/students will use the different settling rates of sand-, silt-, and clay-sized particles to find the percentages each in two different soils.
2. Members/students will classify a soil into one of 12 textural classes using the textural triangle.
3. Members/students will learn how mineral particle sizes impact soil properties and generalize how textural classification relates to soil properties.

Preparation:

Soil Texture by Measurement Experiment
Materials Needed:

- 2 different soil types that vary substantially in their content percentages of sand, silt and clay. Amount needed depends on number of class groups and jar size, but approximately 2 cups of each soil per group. Note: You may want to "create" a soil by adding lots of sand (a little makes cement) or bentonite clay. See "Soil Erosion Demonstration" for more details.
- Soil pulverization device (hammer and baggie, mortar and pestle, food processor, etc.
- 2 identical tall, slender jars (like a quart jar) with lids for each group (small classes could work as one large group)
- 2 teaspoons of powdered, non-foaming dishwater detergent, divided for each group
- Grease pencil, sharpened, for each group
- Ruler, for each group

Preparation Directions:

1. Spread soils on a newspaper to dry. Remove all rocks, trash, roots, etc. Crush lumps and clods.
2. Finely pulverize the soils. This can be done with a mortar and pestle, hammer and zip tight bag, or even a food processor. The better you can pulverize the soil, the more accurate your results will be.
3. Label the soils as "Soil A" and "Soil B." Make sure these labels are available to the students/members.

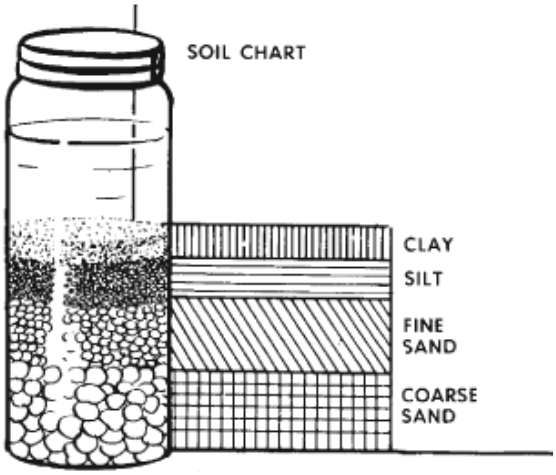
Interest Approach:

In the previous lesson we learned that soils contain a mixture of sand-, silt- and clay-sized particles. The amount of each size present in a soil can impact how a soil behaves. For example, remember that the small rock-filled container required slower pouring to avoid runoff. It had a slow infiltration rate.

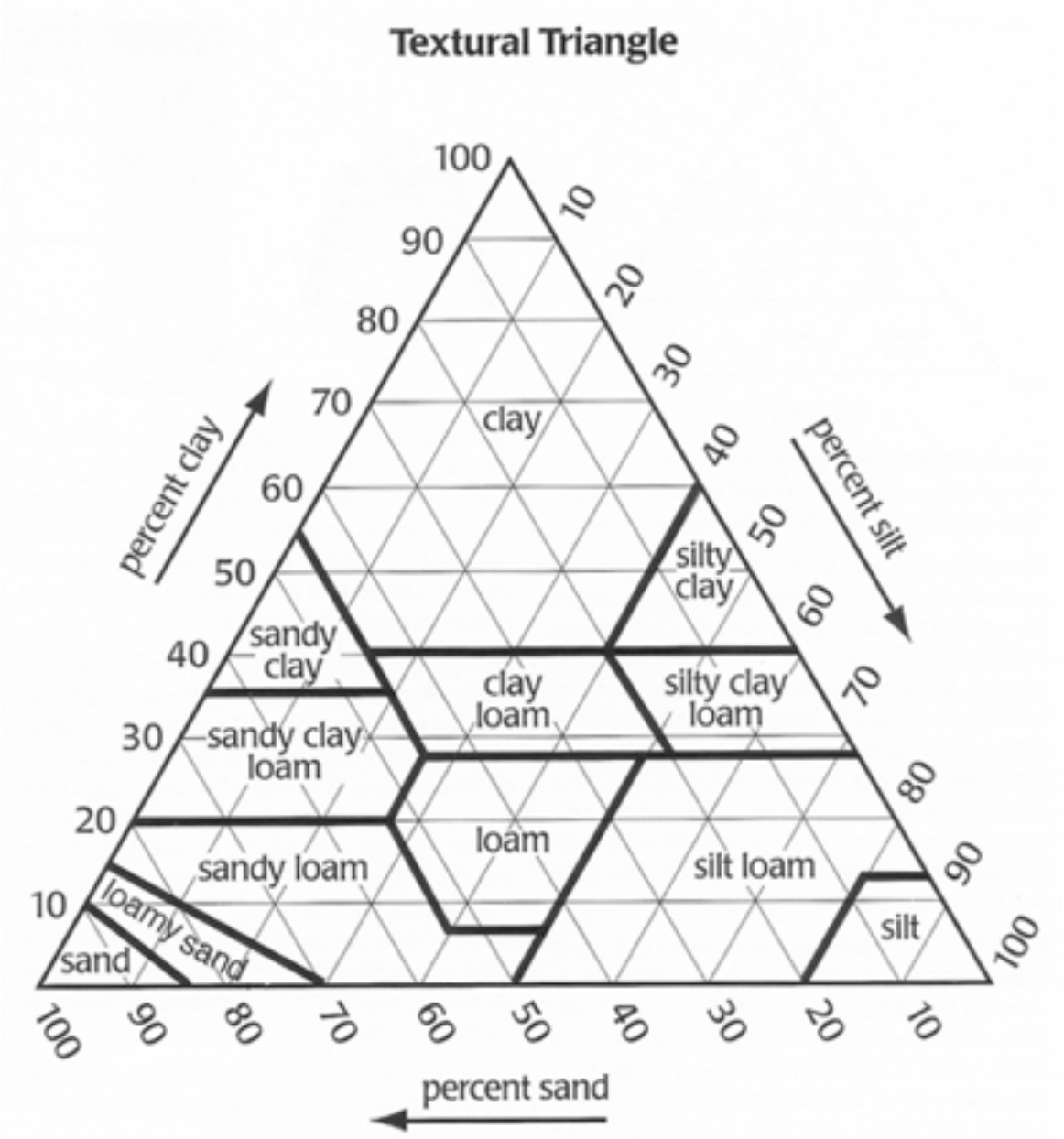
But how can we determine the amount of sand-, silt- and clay-sized minerals in a soil? You can send a sample to a commercial lab to have it evaluated, but if you need a good, but not necessarily perfect answer, you can do the test at home. We will perform this test and then use the results to classify the soil into one of twelve soil types.

Content:

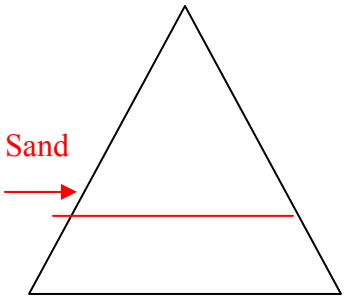
1. Experience: Fill a tall, slender jar (like a quart jar) ¼ full of one soil. Repeat with the second soil. Label the jars as "Soil A" and "Soil B."
2. Add water until the jar is ¾ full. Repeat with the second jar.
3. Add a teaspoon of powdered, non-foaming dishwasher detergent. Repeat with the second jar.
4. Put on a tight fitting lid and shake hard for 10 to 15 minutes. This shaking breaks apart the soil aggregates and separates the soil into individual mineral particles.
5. Set the jars where it will not be disturbed for 2 to 3 days.
6. Soil particles will settle out according to size. After 1 minute, mark on the jars with a grease pencil the depth of the sand.
7. After 2 hours, mark on the jars the depth of the silt
8. When the water clears, mark on the jar the clay level. This typically takes 1 to 3 days, but with some soils it may take weeks.



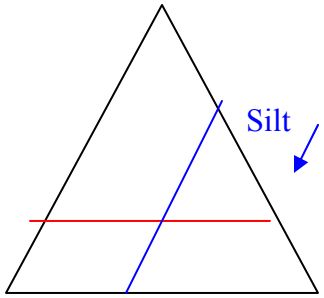
9. Share: Measure and record (on the included worksheet) the height of the sand mark from the bottom of the jar. Repeat the process for the silt and clay height marks.
10. Process: Calculate the sand measurement, silt measurement and clay measurement and record them on the worksheet (calculation directions/tips on worksheet).
11. Add the sand, silt and clay measurements to find the total. (Tip: this should be the same as the "height to clay.")
12. Generalize: Calculate the percentage of sand, silt, and clay. Divide the sand measurement by the total. Convert decimal to percentage. Record answer and repeat to calculate the silt and clay percentages.
13. Apply: Use the soil texture triangle to look up the soil texture class. Record answer on your worksheet.



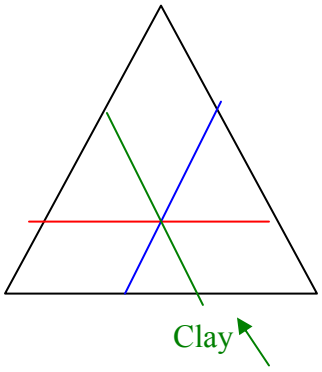
a. Start with the clay percentage of your soil. Find the percentage on the left-hand side of the textural triangle. Use a pencil or pen to mark the clay percentage line straight across the triangle.



b. Next find the silt percentage of your soil on the right-hand side of the textural triangle. The silt lines angle down. Use a pencil or pen to mark the silt percentage line down at the same angle as the line.



c. The lines should intersect within a labeled shape for a soil type. Just to be sure you correctly made your lines, find the sand percentage on the bottom side of the textural triangle. The sand lines angle up to the left. Use a pencil or pen to mark the clay percentage line up at the same angle as the line. All three lines should intersect at one point. The surrounding shape will be labeled the soil texture (sometimes called soil type).



14. Compare your soil textural class answers for soil A and soil B with another group. If they differ, compare the sand, silt and clay percentages. Check that both groups were as accurate as possible with their measurements. If neither group finds a calculation error, do not change your answer. We will use the differences to discuss how we could improve the experiment.
15. Compare class results. What do most groups classify Soil A as? What about Soil B?
16. Consider the following table describing how soil particle sizes impact how soil "behaves" or "acts."

Property/Behavior	**Sand**	**Silt**	**Clay**
Surface area to volume ratio	Low	Medium	High
Water-holding capacity	Low	Medium to high	High
Ability to store plant nutrients	Poor	Medium to high	High
Nutrient supplying capacity	Low	Medium to high	High
Aeration	Good	Medium	Poor
Infiltration	High	Slow to medium	Very slow
Internal drainage	High	Slow to medium	Very slow

Organic matter levels	Low	Medium to high	High to medium
Compactability	Low	Medium	High
Susceptibility to wind erosion	Moderate	High	Low
Susceptibility to water erosion	Low	High	Low if aggregated, high if not
Sealing of ponds and dams	Poor	Poor	Good
Limiting pollutant leaching	Poor	Medium	Good

(After Brady and Weil, 2008)

Summary:

- The percentage of sand-, silt- and clay-sized particles in a soil can be used to determine the soil texture.
- Soil texture is one of the most important single properties of soil. It influences water movement and retention. It determines the amount of surface area, affecting chemical reactivity and nutrient-holding capacity. Soil texture is a factor in the erosion potential of the soil.

Assessment:

Answers in red.

1. Use the textural triangle to determine the soil texture of the following soils.

Percent Clay	Percent Silt	Percent Sand	Soil Texture Class
50	20	30	Clay
20	60	20	Silt loam
30	60	10	Silty clay loam
20	40	40	Loam
30	40	30	Clay loam

2. Using the property/behavior chart and the soil textural triangle, predict which of these three soils…

	Sandy loam	Clay	Silt loam
Most susceptible to erosion (wind and water)	□	□	□
Holds the most water	□	□	□
Highest plant nutrient availability	□	□	□
Best aeration – air throughout the soil	□	□	□
Fastest water infiltration – water into soil surface	□	□	□

Soil Type or Texture

Label: _____

Height to Sand: _____
(1 min)

Height to Silt: _____
(2 hrs)

Height to Clay: _____
(+2 days)

Sand Measurement: _____
(Height Sand)

Silt Measurement: _____
(Height Sand – Height Silt)

Clay Measurement: _____
(Height Clay – Height Silt)

Total: _____

% Sand: _____

% Silt: _____

% Clay: _____

Soil Type/Texture:

_____

Label: _____

Height to Sand: _____
(1 min)

Height to Silt: _____
(2 hrs)

Height to Clay: _____
(+2 days)

Sand Measurement: _____
(Height Sand)

Silt Measurement: _____
(Height Sand – Height Silt)

Clay Measurement: _____
(Height Clay – Height Silt)

Total: _____

% Sand: _____

% Silt: _____

% Clay: _____

Soil Type/Texture:

_____

References:

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Frey, Crystal et al. "Soil Texture - Physical Properties." The Cooperative Soil Survey. 2010. University of Missouri. http://soils.missouri.edu/tutorial/page8.asp

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Whiting, David, Carl Wilson and Adrian Card. Estimating Soil Texture Sandy, Loamy, or Clayey." 2003. Colorado State University Cooperative Extension. 26 Aug. 2010. http://culter.colorado.edu:1030/~kittel/SoilChar(&RibbonTest)_handout.pdf

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