**Supplementary Material**

**Title:** Field Science in the Age of Online Learning: Dynamic Instruction of Techniques to Assess Soil Physical Properties

**Authors:** Eve-Lyn S. Hinckley1,2\* and Scott Fendorf3

**Affiliations:**

1Institute of Arctic and Alpine Research, University of Colorado-Boulder, Boulder, Colorado 80303, USA

2Department of Environmental Studies, University of Colorado-Boulder, Boulder, Colorado 80303, USA

3Department of Earth System Science, Stanford University, Stanford, California 94305, USA

\*Corresponding Author: eve.hinckley@colorado.edu

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The following pages are a series of instructions, figures, and prompts to support instructors and students in completing the course module, “Soil Observations and Interpretation,” which teaches a foundation in soil texture and color analysis. The course instructor can edit these materials as desired to support the focus and modality of their course. At minimum, in the ‘Course Module Instructions,’ the instructor can modify the document heading.

**[COURSE NAME] Instructor: [NAME]**

 **Teaching Assistant: [NAME]**

Course Module Instructions: Soil Observations and Interpretation

Pre-class Preparatory Materials:

* Chapter 4: Soil Architecture and Physical Properties in Weil and Brady (2016) *The Nature and Properties of Soils*.
* [Additional texts assigned by the Instructor]

Learning Objectives:

1. Demonstrate ability to interpret the soil texture triangle.
2. Demonstrate ability to use the “texture by feel” method to determine different soil textural classes.
3. Demonstrate ability to determine soil color using the Munsell color chart (or Smartphone application).
4. Synthesize observations to make an informed guess about unknown soils’ likely origin.

Materials and Equipment:

* One bag of each unknown soil
* Squirt bottle filled with water
* Munsell color chart (hardcopy book or downloaded application for Smartphone)
* Method description and assignment handouts

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This exercise will provide you with tools to understand more about soil properties. You will describe several unknowns using texture analysis (the “texture by feel” method) and color. Each one of these measures can be used to grant insight into where the soil came from on the landscape (soil horizon within a profile, topographical position, region), how water is stored within or moves through it, and what chemical reactions, mineralogy, and geology dominate.

Your first task is to practice using the soil texture triangle (Figure 1). This ternary diagram allows you to determine the name of the soil texture if you know the percent sand, silt, and clay fractions. Make sure that you are comfortable using this common tool.

Your second task is to practice the “texture by feel” method (Figure 2). This method uses a flow chart to guide you through exploring the properties of soils with unknown fractions of sand, silt, and clay to determine the soil texture. The texture names on the flow chart correspond to sections of the texture triangle. In your data table, record your best estimate of the soil texture for each soil.

Your third task is to determine the color of the soil using a Munsell color chart (Figure 3). To do so, wet a small amount of the unknown soil in your hand/on a finger, and match it to the appropriate color in the Munsell color chart. Remember: there are three components of color: *hue* (spectral color, the page), *value* (lightness or darkness, labeled vertically on each page), and *chroma* (intensity, labeled horizontally on each page). Record these three components of color in your data table. Each combination of hue, value, and chroma corresponds to a color name (e.g., 2.5YR 6/1 is “reddish gray”). The color name is on the page opposite the color chip. In general, we report the “wet” color value for a soil. However, if you were in a situation in which you could not report the wet value, you would note that you are reporting the “dry” value. Write the color name in your data table.

Your final task is to interpret the observations that you have made about each soil to make an informed guess about its origin. Use your texture and color data to assess the likely environment from which that soil came and to discuss how that soil might affect other ecosystem properties (e.g., water flow, nutrient cycling, plant growth). Does it come from an oxidizing (aerated) or reducing (water-logged) environment? (Hint: consider the color.) How well does the soil likely hold water? (Hint: think about the size of the soil particles and the likely pore structure of the soil matrix when it is in an intact soil profile.) Write your ideas in your data table.

You may work in groups of three to learn the methods and discuss your findings, but you will each turn in your own work. Please come up with a group name and record it on your data table.

**Using the Soil Texture Triangle**

Practice determining the soil textural class using the soil texture triangle:

1. 50% sand, 30% silt, 20% clay = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. 25% sand, 60% silt, 15% clay = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. 5% sand, 85% silt, 10% clay = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. If you had a soil with 10% sand and you wanted to make sure that it had “clayey” properties in its soil textural class, what percentage of silt and clay might it have?
5. If you had a soil with 60% clay and you wanted it to be a silty clay, what percentage of sand and silt might it have?



**Figure 1.** USDA Soil texture triangle.

**Figure 2.** Flow chart to determine soil texture by “feel”. In the field, the textural class of a soil sample can be determined by feel with a high degree of accuracy. Once an individual has developed their skill by practicing this technique, as well as handling a variety of soil standards, they can often gain the ability to determine the actual percentages of sand, silt, and clay using only their hands. (Modified from Thien SJ. 1979. A flow diagram for teaching texture by feel analysis. *J Agron Educ*, 8, 54-55.)





**Figure 3.** Example of how to read the Munsell color chart.

**Soil Description Datasheet**

Your Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Group Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| **Sample ID** | **Texture name**  | **Color****(Hue/value/****chroma; name)** | **Environmental interpretation**  |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |

**Application: Post-exercise Challenge Questions:**

A farmer is dissatisfied with the quality of soil on his farm. She asks you, now a trained soil scientist, to provide advice on how he could “build” a suitable soil for growing crops.

1. What is the target soil texture and why? Specifically, what properties will the soil have, based on its texture?
2. You remember that soil organic matter can be really important in agricultural soils. Why? What beneficial properties does it have for plant growth and soil health?

**Metacognition: Post-exercise Reflection**

1. What was challenging about learning these techniques for assessing soil properties and why? What was easier than you expected and why?
2. If you were assessing soil color and texture in the field (as opposed to from a sample in a bag), what additional information would you have that would help your interpretations about the soil?