SUSTAINABLE BIOECONOMY
FOR ARID REGIONS

SBAR

SOUTHWESTERN SOIL EXPLORATION

OVERVIEW

This lesson introduces students to the soils of the Southwestern United States. Students will calculate the percentage of sand, silt and clay in a soil sample. Using Norther Arizona University's Southwest Virtual Museum, students will explore how soil type influences the pottery styles of indigenous cultures in the Southwest.

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SOUTHWESTERN SOIL EXPLORATION

STUDENT LEARNING OBJECTIVES:

After completing this lesson, students will demonstrate:

1. Understanding of the major components of soil.
2. Understanding of soil texture, soil properties, and how to determine soil texture by hand.
3. Ability to estimate specific type of soil using two methods: texture by feel and soil triangle.
4. Understanding of the ways in which soil has influenced cultures in the Southwest.

TIME REQUIRED:

10 to 15 minutes teacher preparation
Part 1: What is soil texture? 15 to 20 minutes
Part 2: Exploration of Southwest Soil through Pottery 20 to 25 minutes
Part 3: Soil Texture Triangle Activity 25 to 30 minutes

RESOURCES:

1. Southwestern Soil Exploration Lesson Plan
2. Southwestern Soil Exploration PowerPoint: Soil: More than Just Dirt
3. Southwestern Soil Exploration Worksheet

EQUIPMENT AND SUPPLIES NEEDED:

1. Device with internet access for part 2: Exploration of Southwest Soil Through Pottery
2. 1 gallon of tap water

Each participant will need:

1. Safety goggles
2. Southwester Soil Exploration Worksheet
3. A clear plastic or glass container that holds at least 8 oz. of water
4. Approximately 1 cup of soil that is mostly free of organic matter such as sticks and dead leaves
5. A plastic spoon
6. A ruler with centimeter measurements

THIS LESSON PLAN WOULD WORK WELL AS PART OF:

- Chemistry curriculum
- Plant biology curriculum
- Earth Science or Environmental Science curriculum

THIS LESSON IS ALIGNED TO NGSS, COMMON CORE, FFA and AFNR STANDARDS. See standards detail on page 7 and 8.

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1. Part 1: What is Soil Texture? (15 – 20 minutes)

Begin PowerPoint presentation, Soil: More Than Just Dirt. Review slides with students using lesson plan as a guide.

Slide 2 (5 minutes): Give students time to complete the bell ringer. When they are done, elicit student responses. The point of this question is to get students to think about the components of soil, and since the next few slides go over this information, the important thing is to elicit student ideas.

Slide 3 (3 minutes): Explain the components of soil. If possible, integrate some student responses from the first slide.

Slide 4 (1 minute): Explain the objectives of this lesson.

Slide 5 (3 minutes): Have student read the two quote and reflect on what they mean. Then, explain the general idea of soil conservation that informs native nations and their approach to soil. In the notes of the slide is the following text that you can use to help explain "Although the way soils are used and classified in different Native American cultures are varied and diverse, generally the indigenous perspective on soil is that it is to be protected and preserved for future generations. In other words, soil is not just to be used but also restored so that can be sustained for many generations." This slide is meant to "preview" part three, in which students will learn more about the indigenous perspective on soil.

Slides 6-7 (4 minutes): Now it is time to introduce students to texture, which consists of three particle sizes: sand, silt, and clay. The diagram on Slides 6 and 7 show students how the particle sizes compare to one another. The main idea is that texture is the percentage of each soil type in a soil sample.

Slide 8 (minutes): Introduce the soil texture triangle and why the soil needs to be prepared for using this tool. The soil texture triangle is a fast way to analyze the soil type and is fairly accurate when compared to other methods or more expensive chemical tests.

Slide 9 and 10 (10 minutes): The students will prepare the soil to conduct an analysis that is usually more accurate than methods like the texture by feel method. Give each student or small group a soil sample, a transparent glass or plastic container, and a spoon. Make sure each has the worksheet.

Remind students to remove rocks, sticks or leaves. They need to "clean" their soil samples so that only soil is going in the container.

Slide 10: Explain the instructions before providing each group with about 10 ounces (296ml) of water. Follow the steps on the slide. Once the soil is ready, have students pour in water at a slow steady rate until the water level is about ¾ of the way to the top of the container. Now, students need to

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continuously stir the soil water mixture with a spoon for at least three minutes. After all groups are done timing the stirring for 3 minutes, they can put their samples in an out of the way location. Make sure soil samples are put in a place where they won't be bumped or jostled. They can be left overnight but need at least 30 minutes to settle.

Part 2: Exploration of Southwest Soil through Pottery (20 to 25 minutes)

Students will explore a virtual museum, understanding the linkages between soil type and pottery. Students can work individually on devices with internet access or can work as a group to answer the questions on their worksheet (Southwestern Soil Exploration Worksheet)

Slide 11 – 12 (5 minutes): This activity explores how soil is influenced by geography, as seen in pottery of the southwest region. First have students go to the interactive map at the American Southwest Virtual Museum https://swvirtualmuseum.nau.edu/ Then they click on ENVIRONMENTS, and then click on the MOGOLLON RIM.
Have students find the section on GEOLOGY and summarize this information in 2 sentences on the handout. The important point is that the geological conditions of the region have resulted in extensive deposits of copper, which is mined around Clifton and Globe. If you can project your screen for students to see, you can walk them through this step as they answer the question.

Slide 13 (4 minutes): On the right-hand side of the page, there is a list of pottery types. Have students find the MIEMBRES and look at the three examples.

- What do these three examples of pottery have in common? (*the pieces all have a similar design in red, which shows the influence of the geology*)
- Do the materials match the geology of the Mogollon region? (*the color most prominent is a reddish color from the copper*)
- Do you think soil type and the geology of the region influenced the design of these pieces? (*answers will vary, but all should be affirmative, the geology influenced the design and materials*)

Slide 14 (4 minutes): First have students go back to the interactive map at the American Southwest Virtual Museum https://swvirtualmuseum.nau.edu/ Then they click on ENVIRONMENTS, and then click on the COLORADO PLATEAU. Have them find the section on GEOLOGY and summarize this information in 2 sentences on their handout. (*Sandstones, shales, and limestones are common, as are fantastic rock formations molded by wind and water. Volcanic rocks are also common in those areas of the Plateau with volcanic history. Also, the rivers of the Southwest provided microenvironments of immense importance*)

Slide 15 (5 minutes): On the right-hand side of the page, there is a list of pottery types. Have students find the ROOSEVELT RED WARE and look at three examples.

- What do these three examples of pottery have in common? (*The pieces all have a similar design in black, which shows the influence of geology*)
- Do the materials match the geology of the Mogollon region? (*The color most prominent is a dark color from the darker volcanic rocks*)

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- Do you think soil type and the geology of the region influenced the design of these pieces? (*Answers will vary, but all should be affirmative, geology influenced the design and materials*)

Slide 16 (5 minutes): There are several concluding questions that ask students to compare what they have observed.

- What is different about the geology of the MOGOLLON and COLORADO PLATEAU areas? (*Soil types, climate, lifestyle are all different*)
- How is this reflected in the pottery produced in each region? (*Observation of the color and design of the pottery will be answers*).

Finally have students watch the following video https://vimeo.com/68407614 (also in the video section of the American Southwest Virtual Museum website). A Hopi archaeologist talks about the significance of pottery to his people. This will help students answer the last question:

- What is one thing that is represented by pottery other than its practical uses? (*A connection with ancestors, a communication tool, and a form of expression are all answers*)

Part 3: Soil Texture Triangle Activity (25 to 30 minutes)

Students return to their soil sample that has been settling for a minimum of 30 minutes.

Slides 17-20 (5-10 minutes): Once the soil has settled, there should be 3 distinct layers. The bottom layer of the soil sample represents SAND. The middle layer represents SILT. The top layer represents CLAY. Have students measure the height (in mm) of each layer. To calculate the percentage of each soil type, you will also need the total height in cm of all the soil in the cup. Slide 13 shows an example calculation, all students need to do is divide the height of each layer by the total height of all the soil, then multiply by 100 to get the percentage of each layer.

Slides 21-23 (5 minutes): Now students can find the soil type using the soil texture triangle. At the bottom of the triangle, they find the percentage that represents SAND and use a ruler to trace a parallel line to the closest grey gridline through the rest of the triangle. On the right of the triangle, they find the percentage that represents SILT and use a ruler to trace a parallel line (down, to the left) to the closest grey gridline through the rest of the triangle. On the left of the triangle, they find the percentage that represents CLAY and use a ruler to trace a parallel horizontal line to the closest grey gridline through the rest of the triangle. The region where all three lines intersect is the soil type. You can ask students if the soil type they found was what they expected based upon the texture by feel analysis.

Slides 24-26 (5 minutes): Now, a brief discussion of how soil texture influences the property of soil can start- porosity is the space between grains of sand and determines how much water stays in soil (water holding capacity) and how fast the soil drains (drainage). This may not seem important at first to students but slide 18 shows how different soil types determine what type of food will grow in that soil. Soil texture has had a large effect on human history through just this factor alone, and part three of this activity can show some other ways soil influences culture through looking at indigenous cultures in the southwest.

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Slide 27 – 29: Wrap up (5-10 minutes) Wrap up words

- Name the three soil texture types. (*Sand, silt, and clay*)
- Name three living components of soil. (*Bacteria, fungi, bugs, larger organisms like prairie dogs, etc.)*
- How does soil texture affect food grown in an area? (*Since texture affects how much water is held in soil and how long it stays there, it affects the type of plants that can grow in the soil. Some plants like carrots do better in sandy soils with high porosity, and some plants like broccoli do better in clay soils with high water retention*.)
- Name another aspect of life that is affected by soil besides pottery. Your example can be from recently in your own life, or from the examples of native southwestern peoples in the past and present. Answers will vary but can be about any aspect of human food or building enterprises.

DEFINITIONS:

Physical Weathering: mechanical actions like abrasion (rocks colliding with each other, changes in temperature

Chemical Weathering: change in the chemical make-up of rocks after reacting with water, air or other chemicals

Biological Weathering: breakdown by living organisms like burrowing of animals, plant roots growing into cracks of the rocks.

Soil Texture: The relative proportion of the three types of particles (sand, silt, and clay) in a specific soil.

Porosity: The number of open spaces or voids or pores between soil particles.

Drainage: Process by which water moves downward from upper soil layers to lower layers by gravity.

Soil water holding capacity: The ability of a soil to hold on to water.

STANDARDS DETAIL:

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NGSS

MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and
populations of organisms in an ecosystem.
MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Common Core

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.
RST.6-8.3 Follow precisely a multistep procedure when carrying our experiments, taking measurements, or performing technical tasks.

CCSS.ELA-Literacy.RST.9-10.7: Translate quantitative or technical information expressed in words in a text into a visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
CCSS.ELA-Literacy.RST.9-10.9: By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Common Core Math Practices

MP2: Reason abstractly and quantitatively.
MP5: Use appropriate tools strategically.
MP6: Attend to precision.

AFNR Career Ready Practices

CRP.02: Apply appropriate academic and technical skills. Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive.
CRP.02.01. Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.
CRP.02.02. Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.
CRP.04: Communicate clearly, effectively, and with reason. Career-ready individuals communicate thoughts, ideas and action plans with clarity, whether using written, verbal and/or visual methods.
CRP.07: Employ valid and reliable research strategies. Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies.
CRP.08: Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.11. Use technology to enhance productivity

FFA Precept

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FFA.PL-A. Action: Assume responsibility and take the necessary steps to achieve the desired results, no matter what the goal or task at hand.
FFA.PL-E. Awareness: Understand personal vision, mission and goals.
FFA.PL-F. Continuous Improvement: Accept responsibility for learning and personal growth.
FFA.PG-J. Mental Growth: Embrace cognitive and intellectual development relative to reasoning, thinking, and coping.
FFA.CS-M. Communication: Effectively interact with others in personal and professional settings.
FFA.CS-N. Decision Making: Analyze a situation and execute an appropriate course of action.
FFA.CS-O. Flexibility/Adaptability: Be flexible in various situations and adapt to change.

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Matt Swanson is a lifelong Arizona resident and an educator with experience teaching science at the middle school and high school levels. He is now working for the Arizona State 4-H office as a curriculum specialist, where he continues to enjoy bringing learning experience to youth. He received both his undergraduate degree in philosophy and his graduate degree in science education at the University of Arizona.

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