Is Soil Alive?

Key Topics: Soil Composition, Soil Formation, Soil Food Web, Decomposition, Weathering, Nutrients, Humus, Top Soil, Sand, Clay
Grade Levels: 3-5
Inside and Outside

Lesson Overview:

In this lesson students will learn that soil is home to billions of organisms that play vital roles in decomposition and ecosystem health. Students will use their senses to discover qualities of different soil types and understand what they provide for plants in terms of food, water, and shelter. They will then practice setting up an experiment to test which mixture of soils help support plant growth best!

Activities:

Part 1 - Discussion and Explore Soil Life Activity: 15 minutes
Part 2 - Sensory Soil Activity and Water Experiment: 20 minutes
Part 3 - Soil Mixture Experiment Design and Setup: 25 minutes

Suggested Activities and Learning Objectives by Grade Level:

- 2:
  - 2-LS4-1 Compare the diversity of life found in different soil types or in different areas of the same soil type.
- 3:
  - 3-LS4-3 What soil type is best for growing vegetables? What types of life do you find in different areas of soil?
  - 3-LS4-4 How can we change or amend soil to make it more suitable for vegetables?
  - 3-5-ETS1-2 How do different soil types affect plant growth?
- 4:
  - 4-LS1-1 How does soil affect root and plant growth?
  - 4-ESS2-1 What soils are more affected by erosion?
- 5:
  - 5-PS1-3 Categorize soil types based on their properties.
  - 5-PS1-4 Investigate whether mixing two soils result in a new soil.
  - 5-ESS2-1 How does water interact with soil? How do life forms in the soil interact with the soil to change it?

Essential Question(s) that Connect CCCs and SEPs:

- How is soil created? What explains how rocks, branches, leaves, sand, and other natural materials develop into soil? (Cause and Effect; Construct Explanations and Design Solutions).

- What can you observe to see how soil structure affects plant growth? What can you measure as evidence to compare the effect of different soil compositions on plant health? (Structure and Function; Planning and Carrying out Investigations; Engage in Argument from Evidence)
- What does the data tell us about how changes to the overall structure of your soils, or in other words soil composition, affect the function of plant growth and health? How can you best communicate about this relationship between soil composition and food, water, and shelter for plants? (Structure and Function; Analyzing and Interpreting Data; Obtaining, Evaluating, and Communicating Information)
- Can I communicate how the nutrients humans and other animals need to function originate from the soil? How does calcium from the soil become ingested by humans? (Energy and Matter; Obtaining, Evaluating, and Communicating Information)

Materials:

Part 1 - Discussion and Soil Life Activity

- Hand trowels (1 per group of 4 students)
- Magnifying glasses (1 per group of 4 students)
- Copy of Soil Organisms in One Square Meter of Soil
- Copy of ID Soil Organisms

Part 2 - Sensory Soil Activity and Water Experiment

- Containers of the different soil types: sand, clay, and humus (1 of each type per group of 4 students)
- Three water chimneys: one each for sand, clay, and humus.
    - (3) 1 liter plastic bottles
    - 3 pieces of cheesecloth
    - 3 rubber bands
    - A sample of the three soil types
- Timer
- 3 measuring cups for 250 ml of water

Part 3 - Soil Mixture Experiment Design and Setup

- Containers of the different soil types from the Sensory Soil Activity
- Containers for planting eg. black pots, reused milk carton with holes punched on bottom for drainage, etc. (1 per group of 4 students)
- Something for each group to measure proportions with eg. dixie cups (1 per group of 4 students)
- Bean seeds
- Popsicle stick and pen (1 per group of 4 students)
- Which Soil Is Best? Student Lab Sheet (ask classroom teacher to print 1 per group of 4 students)

EG Team Support Needed:

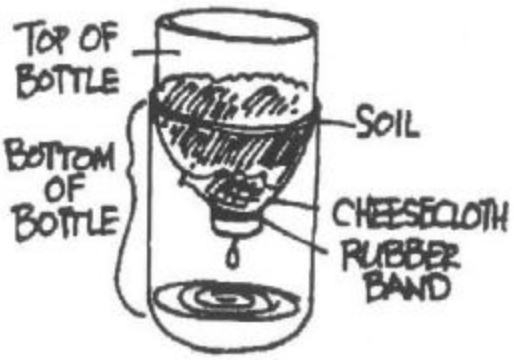
- Collect plastic liter bottles and containers for planting

Prep:

This lesson is designed to take place outside! Students will be digging in soil to make educated guesses about the amount of organisms in soil, and they will be making their own soil mixes out of sand, humus,

and clay. It will get messy! Alternative options in case of rain: you can bring the soil inside of the classroom with ample newspaper or butcher paper to lay out for easy cleanup. Keep soil inside of containers, and have a large container of soil directly from the garden for the soil life activity.

- Connect with the classroom teacher ahead of lesson and you will then print Which Soil Is Best? Student Lab Sheet, enough for each group of 4 students to have 1 lab sheet
- Also connect with classroom teacher to provide them with: Is Soil Alive - Monitoring Experiment and Wrap Up. They will be responsible for monitoring the experiment, reviewing data, and having the final wrap up discussion. Send this link to them digitally (as the link contains links) to avoid it getting lost and overprinted.
- Set up an outside station for the sensory soil activity. Set out three containers with different types of soil for each group: clay, sand, and humus. If your garden has multiple picnic benches you can set up a container of each of the three soils at each table. Students could also sit with their groups on the ground around the three containers of soil.
- Have the Soil Mixture Experiment supplies organized ahead of time to be passed out to students at their stations.
- Set up three chimneys as in the diagram below. Add an equal amount of a different soil to each one ie. one sand chimney, one clay chimney, and one humus chimney. Label each of the soils (sand, clay, humus)!



Activity Procedure:

Engage:

Begin with a classroom discussion in the seating area in your garden or in the classroom. Elicit students' ideas about soil by holding up a jar full of soil.

Comprehension Check

Write the following underlined questions on the board, record answers, and discuss with the class:

What ingredients make up soil? Many students will list among their ingredients "dirt" or "brown stuff". Challenge them to figure out what the brown stuff is. The simplest answer: It's just smaller pieces of all the other ingredients: crushed rocks, crumpled leaves, twigs, bugs, sand, and so on.

How important is soil? Soil grows the food that all creatures depend on! It is also the habitat for decomposers, which are a vital part to the nutrient cycle and help convert all of our "dead scraps" into usable matter again.

Do you think all soils are alike? In nature, soil types greatly influence the kind of plants that grow in an ecosystem. Cacti seem to thrive in sandy soil while dandelions do well in clay soil.

How is soil created? Can we manufacture soil? What explains how rocks, branches, leaves, sand, and other natural materials develop into soil? (Cause and Effect; Construct Explanations and Design Solutions). Explain that each inch (2.5 cm) of topsoil requires more than 100 year to form, by the processes of weathering and decomposition. Our hands and tools cannot equal the power of weathering and decomposers!

Take a hand raising survey: *How many of you believe that there is life inside of soil? Is soil alive? Who/what lives inside of soil? We are going to find out!*

Action:

1. Remind students what the callback will be for this project (give me 5, silent coyote, chime, etc)! Divide the class into groups of four students. Explain that each group is going to estimate how many organisms live within one square meter of soil. *How long is a meter? What does a square meter indicate?* Using student responses, draw a cube on the board showing the dimensions of a cube meter. Brainstorm how students could estimate the area of one square meter using their bodies. (Each group of 4 can stand in a square with each of their arm spans extended out to a 90 degree angle.)
2. Instruct each group to find an area of the garden and create a square meter. Provide each group with 1 hand trowel for them to observe the soil in their area. Instruct students to not try to dig up a square meter, but rather estimate through digging a smaller area. *Within your square meter, how many organisms do you think live in the soil? Remember your square meter also extends down.. how many feet? You may use your hand trowel and magnifying glasses to dig and observe.*
3. Call students back to the group and discuss their observations and estimates. *What living creatures did your group find within your square meter? How does that organism contribute to the soil? Who else might live in the soil that we cannot see?* Ask students to take 30 seconds to discuss with their groups how many total organisms live in one square meter of soil on average. Record each group's guess on the board.
4. Show students the large laminated copy of Soil Organisms in One Square Meter of Soil and ID Soil Organisms. Point out organisms and numbers, starting from the top of the pyramid down. *Did anyone see this living creature? Do these numbers surprise you? What do the vertebrates eat in this pyramid? We are looking at the soil food web, comprised of organisms eating decomposing matter and returning nutrients to the soil! Soil is alive, with more than 100 billion microorganisms living in a pound (0.45 kg) of soil, in addition to the roots, insects, worms, and other living things we can see in the soil. There is no recipe that could duplicate this substance so full of life and so necessary for life.*

Explore:

Turn student's attention to how soil functions to support plant life. *Do plants need soil to grow?* Vote. *In terms of habitat (food, water, and shelter) what does soil provide for plants?* Write the following underlined words on the board, record answers, and discuss:

<u>Food:</u> *Does soil provide food for plants?* Some students may claim that a plant receives all of its food from the soil. Remind students of photosynthesis. $CO_2 + H_2O$ + Sunlight = Sugars is the definition of photosynthesis. However, plants do intake soil nutrients that are beneficial for their health. Some farmers can tell simply by looking at a plant what nutrient the soil is deficient in. For example, if a red tomato has a rotted bottom, this indicates that the soil is deficient in calcium. *Is calcium a nutrient that we consume as humans? Where do we get calcium from? How does calcium from the soil become ingested by humans?* (Energy and Matter; Obtaining, Evaluating, and Communicating Information) There are many sources of calcium! Dairy is one that commonly comes to mind, but dark leafy greens are also an excellent source of calcium. These vegetables uptake calcium from the soil, so soil that is rich in nutrients helps to produce the healthiest fruits and vegetables for us to eat! We can tell if soil is rich in nutrients by the color. The darker the soil, the more nutrients it has.

<u>Water:</u> *How does the soil help to provide water for plants? Do you think most plants like to sit with water around their stems?* Soil requires both water and oxygen to support plant growth. As water fills the spaces between soil particles, it drives out air, which can cause roots to rot. A good soil must be able to hold some water, like a sponge, but allow for adequate drainage.

<u>Shelter:</u> *What role does soil play in supporting the structure of a plant? Can you remember which plant part serves as the anchor to hold the plant in place? (The roots!)* The roots depend on soil structure to hold them in place. The soil stabilizes the plant while sheltering the roots. *In terms of supporting a plant, how would a loose soil differ from a firm soil?*

Today we are going to observe three different kinds of soil to notice properties of their structures to discuss how well each one could provide food, water, and shelter to plants.

<u>Action:</u>

1. Have students work in their same small groups of 4 students. Invite groups over to the sensory soil activity station, or have a gatherer from each group carry each of the three soil containers over to their stations if they are already seated in groups.
2. Tell the students they will be exploring three different types of mystery soil using all of their senses except for one… taste! Their job is to describe characteristics of the soil and discuss how well each one could provide food, water, and shelter to plants. Remember to look at color for food and particle size for shelter for the plants. We will be doing an experiment shortly to tell us about how each of these soils provides water and drainage for plants.
3. Have students explore the soils for a few minutes. Prompt students to smell the soil. Does it make a sound when you rub it between your fingers? What does that sound and texture tell you about the shape of the particles? What does the color look like?
4. Invite groups to share observations about the three types of soil and record them on the board. Can they identify the type of soil based on their observations? The three types are clay, sand, and humus! Humus is also called topsoil and is rich of decomposed matter such as leaves, twigs, and other plant material.

We are now going to time the passage of water through the different soils to compare water-holding capacity. Students will observe that soils hold water differently depending on their structure.

Action:

1. Ask students to predict which of the three soils will drain the fastest and which the slowest.
2. Designate 3 students to be the "pourers" and 3 students to be the "holders." Have the holders and pourers pair up and hand each a different soil chimney. Designate any other students to be observers and recorders.
3. Be the timekeeper and give the signal to begin pouring. (You can time by using a phone, watch, or having kids count out loud).
4. At the signal each of the pourers should pour 250ml of water into the soil. Keep track of which soil the water percolates through first, second, and third.
5. After the water has mostly run through the soils, compare the amounts left in the bottoms of the containers. *Where is the water that is not in the bottom? How much is left behind in the soil?*
6. Have the class aplaude and thank the volunteers as they return to their seats.

Explain:

Many of the characteristics of these soils are explained by particle size and shape. Draw each soil particle on the board for students to observe. Clay: small and flat; Sand: medium and sharp/jagged; Humus: large or small and spongy

Comprehension Check

Ask students to raise their hands to share:

Which of the soils would you plant a seed in? Why? Which sample would you not plant a seed in? Could one of the soils possibly drown your plant? Which soil would be bad during a drought? Which soil is richest in nutrients? Based on soil particle structure, which soil is the best for stabilizing a plant?

As you can see, each of these soil types have properties that are positive and negative for plants. For example, humus is a rich nutrient source (look at the color!) but it is so loose that it can erode very easily and not provide the best shelter for a plant.

Elaborate:

Plants are like Goldilocks! They like soil that isn't too hard or too soft, soil that isn't too dry or too wet, and soil that doesn't have too many nutrients or too few. If you were to mix these soils together, which ones would you mix and in what proportions to grow the best plant? Why? How can we be sure it is a fair test? Do we need to plant all the seeds the same way? How should we plant them? Do we need to water them in the same way? How should we measure them? Pass out one Which Soil Is Best? Student Lab Sheet per group. Write the agreed-upon planting, watering, and measuring instructions on the board for groups to copy onto their lab sheets. (The back of the seed packet will give good information on how best to plant the seeds and care for the plants.) What can you observe to see how soil structure affects plant growth? What can you measure as evidence to compare the effect of different soil compositions on plant health? (Students should observe: number of days till sprouting, plant height, color, number of leaves, leaf size, etc.) (Structure and Function; Planning and Carrying out Investigations; Engage in Argument from Evidence)

Action:

1. Staying in their same groups of 4, have each student assume a role, for example: the recorder, the mixer, the planter, the waterer. Every student should contribute equally to the decision of what type of soil and in what proportions the mixture should be comprised of. Have students write their soil mix ratio on a popsicle stick and their lab sheet with their names and the date.
2. Distribute one container / pot to each group. Using the soil that is in front of them from the sensory soil activity, Invite the mixer to measure and mix their groups agreed upon soil recipe. Have the recorder record the group's prediction as to how well their plant will grow, along with their reasoning as to why they think that.
3. Walk the groups through the planting steps the class agreed upon as the planters plant the seeds for each group.
4. Instruct each waterer to water their group's pot with the exact amount the class agreed upon.
5. Place all pots in the same location that you agreed upon with the classroom teacher, preferably in a sunny window or greenhouse if available.
6. At this point, the classroom teacher will take over leading the experiment and wrap up discussions. **Please provide teacher with**: Is Soil Alive - Monitoring Experiment and Wrap Up. Remind students to observe their pots daily until sprouting, and then weekly for one month. Also review that as the experiment progresses how important it is to treat all the seedlings equally so they can test which soil the plants prefer. A seed will sprout in many different conditions. It is important for students to follow this experiment for several weeks to see how the plants grow after emerging.
7. Review: What are three things you can measure as evidence to compare the effect of soil structure on plant health? (Structure and Function; Cause and Effect; Engage in Argument from Evidence)

Evaluation:

After four weeks, hold a final summit on "Which Soil Plants Prefer." Ask each group to present their findings about the health of their bean plant. What does the data tell us about how changes to the overall structure of your soils, ie. soil composition, affect the function of plant growth and health? How can you best communicate about this relationship between soil composition and food, water, and shelter for plants? (Structure and Function; Analyzing and Interpreting Data; Obtaining, Evaluating, and Communicating Information) Do the groups agree on which soil recipe was the best for the plant? Remind students that in science, the answers aren't always crystal clear. Often, experiments bring up more questions than they answer. What new questions came up for your groups?

Also, refer back to the Learning Objectives for your grade level and ensure that they have been met by asking the given learning objective question.

Extension Activities:

- Soil to smoothie: How can an apple core turn into a peach? How can some lettuce turn into a sunflower? Find out how through this storytelling activity: Soil to Smoothie Activity Guide and Materials

- Ask students to do research on decomposers, pick their favorite decomposer, and then write and draw a cartoon strip of them hard at work in the compost pile. For inspiration, read: *The Diary of a Worm* by Doreen Cronin.
- The Wonderful World of Wigglers: Soil Tests
- Starting With Soil is a new app from the Center for Ecoliteracy and Whole Kids Foundation offers a playful, visually rich way to help kids understand that soil is a living system full of fascinating relationships. Find it here: https://www.ecoliteracy.org/download/starting-soil Encourage teachers to allow students free or structured time to use it in the computer lab or on their Google Chrome Books in class.
- Conduct a soil shake test with students to learn more about the different components of soil. Follow the "mason jar" activity in this guide: Soil Sampling

Tips and Caveats:

- Emphasize the importance of students listening for and responding to your call back prior to setting them free! There is not much buffer time in this activity.
- Refer to "Space Travelers" lesson plan for a lesson better suited for K-2 grade levels.

Cited Curriculum:

LifeLab - The Growing Classroom: Sensory Soil
Life Lab: Soil Stories
Soil Sampling