NATURE LAB Educator Resources

HOW DIRT WORKS

Subject Area: Science - Natural Resources, Cycles of Matter

Grades: 3-8

Time: This lesson is designed to be completed in three 45-minute sessions.

Essential Questions:

- Why is soil a valuable resource?
- How do humans rely on soil?
- Why is it important to monitor and maintain the health of soil?
- What are some of the strategies used to improve and maintain the health of soil?

Purpose and Overview:

Students learn about the value of soil as a natural resource (regulates water, sustains plant and animal life, filters pollutants, cycles nutrients and supports structures). Then explore the importance of having/maintaining healthy soil. They will explore different individuals' descriptions of healthy soil. For example, to an agriculturalist, healthy soil means highly productive land that sustains or enhances productivity therefore enhancing profits; to a consumer it means plentiful, healthy and inexpensive food for present and future generations; to an environmentalist it means functioning at its potential in an ecosystem with respect to biodiversity, water quality, nutrient cycling, and biomass production.

Theme:

Soil provides food for many species and provides nutrients for plants to grow for other animals to eat.

Introduction:

In this lesson, students learn the value of soil and its role as a valuable natural resource. Students will investigate how humans and many other organisms rely on soil. They will also explore why it is important to monitor and maintain the health of soil.

Soil is the solid material on Earth's surface that results from the interaction of weather and biological activities with the underlying geologic formation. Soil is created from rocks that have been broken down, organic matter, water and air. All soil types are made of varying amounts of silt, sand, and clay. Many different colors can be present in soil depending on the minerals and chemical and biological reactions within the soil.

Soil is typically found in layers that are distinguished by different colors, textures, and structures. Soil layers also have different amounts of organic matter and gravel. When humans work the land, for agriculture, home building, and road construction, they change the landscape to fit different purposes. Land use involves changing the landscape, including the soil, rocks, and vegetation. Humans change the land differently than how nature changes the land. Many animals depend on soil. Some we can see but there are also billions of microscopic organisms, such as bacteria, protozoa, fungi, and algae, which inhabit and enrich the soil.

Objectives:

The student will…

- Describe soil and its importance to an ecosystem.
- Diagram soil layers or horizons.
- Conduct mini-investigations to determine how soil functions to regulate water, filter, sustain life, cycle nutrients, and provide support.
- Examine the role of soil for different organisms.
- Explain the relationship between humans and soil.
- Examine and describe the need to monitor soil health.
- Create a worm composting bin to observe the process of decomposition.

Standards:

Next Generation Science Standards

Disciplinary Core Ideas

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- LS4.D: Biodiversity and Humans
- ETS1.B: Developing Possible Solutions

Crosscutting Concepts

- Systems and Models
- Cause and Effect

Science and Engineering Practices

- Developing and using models
- Constructing explanations

Performance Expectation 5th Grade

- 5-LS2-1: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Performance Expectations Middle School

- MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Common Core English and Language Arts Standards for Science and Technical Subjects and Writing Grades 6-8

- CCSS.ELA-LITERACY.RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- CCSS.ELA-LITERACY.RST.6-8.7 - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- CCSS.ELA-LITERACY.WHST.6-8.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

Vocabulary:

Dust Bowl: A period of severe dust storms causing ecological and agricultural damage.

Nutrients: Substance that provides food for growth and life

Organic Matter: Material made of living or once living things.

Pollutants: Substance that contaminates the water, air or soil.

Soil: The upper layer of earth in which plants grow

Materials:

For teacher:

- Computer, project, screen, Internet

Videos that support this lesson plan:

- *How Dirt Works* Introductory video http://vimeo.com/77792712
- Scientist interview questions:
  - *Soil #1: Valuable Resource* - "Why is soil a valuable resource?" http://vimeo.com/78368785
  - *Soil #2: Humans and Soil* - "How do humans rely on soil?" http://vimeo.com/78368784
  - *Soil #3: Soil Health* - "Why is it important to monitor the health of soil?" http://vimeo.com/78368788
  - *Soil #4: Strategies* - "What are some of the strategies used to improve and maintain the health of soil?" http://vimeo.com/78368782
- *Meet the Scientist: Sophie Parker* http://vimeo.com/77788834

For individual student:

- Notebook paper/journal
- Photocopies of picture puzzle pieces (your choice of photos)

For experiment groups – each group needs the supplies below:

Regulates water

- Nail
- 3 paper cups
- 100 mL beaker to measure dry material
- 2 - 100 mL graduated cylinders
- Water
- Sand
- Peat moss
- Gravel

Sustains plant and animal life

- Seedlings or plants for students to examine

Filters pollutants

- Sand
- 5 oz cup
- Soil
- Grape Kool-Aid

Cycles nutrients

- Carrot chunks
- Ziploc bag full of soil
- Scale

Supports structures

- Knitting needle
- Spool
- Rubber band
- Different locations (with different soil types)

Classroom Activities:

Part 1: Engage

1. Ask students to think about where their food comes from. Do they think most of it is grown or raised locally? Explain to students that most food is grown or raised in other parts of the country or the world, transported, and then purchased at local grocery stores.

2. Ask students, "What comes to mind when you hear the word soil?" Some anticipated responses might include worms, plants, food, water, roots and landscaping. Then, ask students to rank how soil is important to them using a list like the one below:

Soil is important to me . . .

____to filter out pollutants that may contaminate drinking water.

____to provide income for farmers, food companies, clothing companies, and grocers.

____to grow plants for food, oxygen, paper and other products.

____to provide wildlife and insects a habitat.

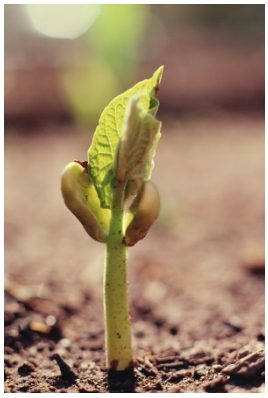
____as a surface for buildings roads, sidewalks and the places where we live.

____to provide food for livestock.

____to walk on.

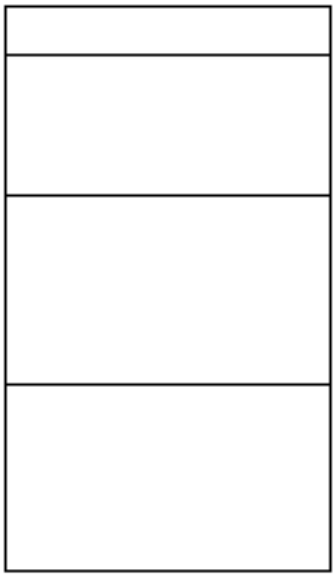
3. Provide students with the definition for **soil**. Soil is a dark brown to black mixture of material found at the upper layer of earth and consists of a mixture or organic materials, clay, and rock.

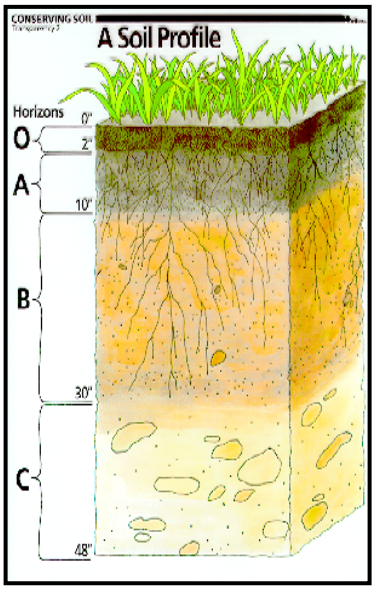
4. After students rank how soil is important to them, ask them to share their list in a small group. You can group students by enlarging and cutting the images on the next page into four or five puzzle pieces and randomly distributing all of them to the class. Students will form their groups by finding other classmates that complete their puzzle. Some images related to soil are included below, but any set of images can be used.



5. Share with students *"How Dirt Works" overview video* and review the guiding questions.

6. Ask students to fold a piece of paper in four sections. First, they can fold their paper into thirds. Then, in one third, you can ask them to fold a fourth section that is about an inch wide (see images below). Share an image of soil horizons and discuss the different layers. Students will identify the following and illustrate them on their soil profile;





   a. O Horizon-This is the surface layer that has large amounts of organic matter in different stages of decomposition. Dead leaves can be illustrated.
   b. A Horizon- The top layer of soil and is where most biological activity occurs. Earthworms, grass, fungi, plant roots and arthropods can be illustrated.
   c. B Horizon- The subsoil and consists of mineral layers. Plant roots also penetrate this layer.

d. C Horizon- Contains large shelves or lumps of rock.

7. Provide students with the definition for **organic matter.** Organic matter is matter composed of the remains of once living organisms and their waste.

8. Explore with students the different values of soil as a natural resource through the following demonstrations.
    a. Regulates water - Soils help to regulate the flow of water from rain. Some water will flow over the surface, some will enter the soil and be retained and some will flow almost straight through to deeper layers below. Much of the water reaching the soil is stored in the soil and is used by the plants that grow in the soil and by the organisms that live in the soil.
        i. Use a nail to punch 2 holes in the bottom of three paper cups.
        ii. Fill the cup with 100 mL of the first material. Suggested materials are sand, peat moss and gravel.
        iii. Place the cup over the graduated cylinder.
        iv. Pour 100 mL of water into the cup of material. Start the stopwatch when you pour the water in the cup.
        v. Measure and record the amount of water dripping from your cup every minute for 5 minutes.
        vi. After the 5 minutes are up, remove the cup of material from above the graduated cylinder.
        vii. Measure and record the total amount of water that dripped into the graduated cylinder. Calculate how much water the material was able to absorb.
        viii. Repeat steps 2-7 for each material.
        ix. Do all soils regulate water the same? Why is it important that soils regulate water?

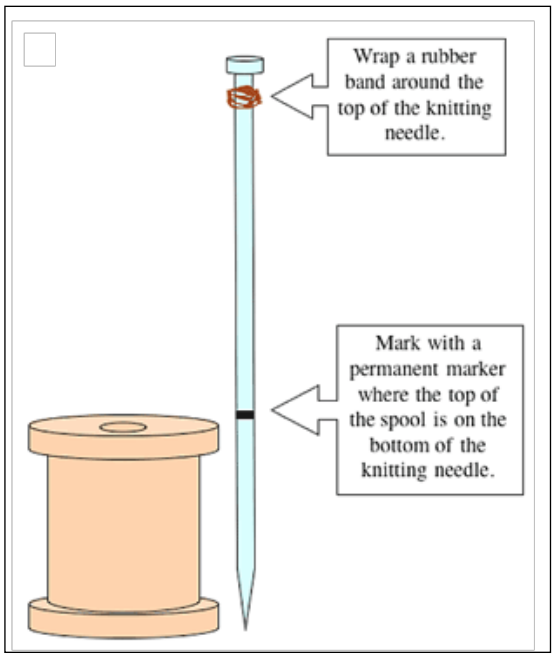
    b. Sustains plant and animal life
        i. Provide plants for students to explore in the classroom or grow a plant from a seedling. Discuss the types of foods that come from plants and the different organisms that rely on plants for food.

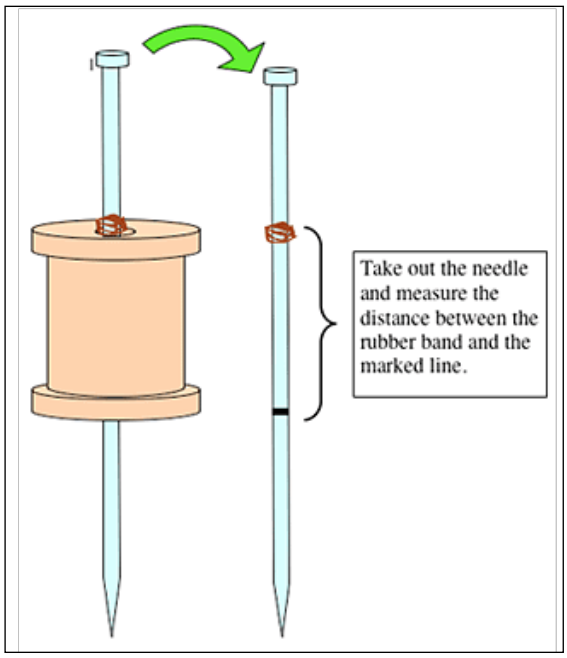
    c. Filters pollutants - Provide students with the definition for **pollutants.** Pollutants are substances they are introduced into the environment, like chemicals or waste. They can contaminate the water, soil, and atmosphere.
        i. Put a layer of sand the width of your pointer finger in the bottom of a 5 oz. cup (with holes in it.)
        ii. Add topsoil until the cup is half-full.
        iii. Put the 5 oz. cup into the 3 oz. cup.
        iv. Pour some of the grape Kool-Aid (pollution) into the top
        i. What color is the Kool-Aid that goes into the cup? What color is the water that collects in the bottom cup? What property of soil does this demonstrate?

    d. Cycles nutrients - Provide students with the definition for **nutrients.** Nutrients provide substances needed for life. In the case of plants, important nutrients are nitrogen, phosphorous, and potassium.

i. Students can design and conduct experiments to determine what environmental factors favor decomposition by soil microbes.
ii. Use chunks of carrots for the materials to be decomposed. Guide students to conduct their experiments in plastic bags filled with dirt.
iii. Every few days students remove the carrots from the dirt and weigh them. Depending on the experimental conditions, after a few weeks most of the carrots will have decomposed completely.
iv. Soils are the major site for plant nutrients. How does decomposition help cycle nutrients?

e. Supports structures
   i. Soil scientists and engineers conduct compaction tests on soil to assess its ability to withhold structures. Students can test the compaction of soil in different places of their school building with simple materials. Some soils can be a problem to build on. For example, some clay soils swell when wet but shrink when dry.
   ii. Place a knitting needle into a spool (see images below).





iii. Place the spool and knitting needle, pointy side down, onto a table. Mark where the knitting needle sticks out of the top of the spool with a permanent marker. This line is zero.
iv. Tightly wrap a rubber band around the knitting needle and push it towards the non-pointy, capped end of the needle. You will use this to mark the depth of your soil measurements.
v. At each location, place the spool on the ground pointy side down. Push down hard on the knitting needle until it stops moving into the ground. Slide the rubber band down against the top of the spool.
vi. Remove the knitting needle from the ground and measure the distance between the line and the rubber band with your ruler.
vii. Why do you think scientists and engineering conduct this type of test?

9. Share the *Meet the Scientist: Sophie Parker* video followed by the scientist video *Soil #1: Valuable Resource* answering the question, "Why is soil a valuable resource?"

10. After the video, pose the same question to students and ask them to summarize their earlier investigations and scientist video in two minutes by writing a "Two Minute Paper." A Two-Minute Paper is a student centered reflection strategy. Students are given two minutes to respond to the posed question in writing. Student summaries may include filtration and storage of water, decomposition and recycling of nutrients, roots in the soil transporting nutrients to plants, and that soil is the building block of a healthy system.

Part 2: Explore

1. Explain to students that soil means different things to different groups or individuals. Guide students to join back with their puzzle groups and brainstorm what soil means to each role. You may need to define some of the roles for students or can choose to remove or add roles. Students may have some background knowledge around what soil means to these different roles but additional resources such as books and articles could be provided to help them explore.

Soil means something different for each of us. What do you think soil means to a: a) farmer? b) construction worker? c) civil engineer? d) geologist? e) earthworm? f) owner of a dry cleaning business? g) bird? h) hydrologist? i) maple tree?

2. Depending on time available, you may want to assign roles to groups of students instead of them investigating the entire list. For example, one group may consider what soil means to farmers and construction workers while another group considers a civil engineer and geologist. Groups can then share out their ideas as a class and you can open the discussion up for other students to add on.

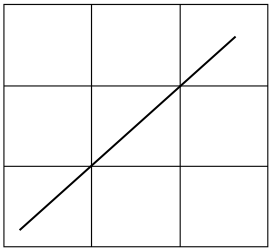
3. Review what soil means to different groups or individuals. Soil means something different to every organism including people, depending on the perspective. Ask students to reflect on whose perspective is closest to theirs. Why? What would life be like without soil?

4. Share the scientist video *Soil #2: Humans and Soil* answering the question, "How do humans rely on soil?"

5. As students watch the video ask them to put each example shared in any one of the spaces on a tic-tac-toe board. If they do not fill up their board by the end of the video,

students can fill in remaining boxes with examples explored in other parts of the lesson. Examples cited in video include products, food, clothes, electronics and medicine.

6. Select a random row of three by drawing a line through three boxes. This can be drawn on a front board. Ask students to look at their tic-tac-toe boards and identify the three examples the line crosses over. Using those three examples, students will write a sentence about how each one is a way humans rely on soil.



Part 3: Explain

1. Provide students with the definition for **Dust Bowl.**

2. Share the scientist video *Soil #3 Soil Health* answering the question, "Why is it important to monitor the health of soil?"

3. Explain to students that poor agricultural practices and years of sustained drought caused what we refer to in United States history as the Dust Bowl. Plains grasslands had been deeply plowed and planted to wheat. During the years when there was adequate rainfall, the land produced plentiful crops. As the droughts of the early 1930s continued, the farmers kept plowing and planting and nothing would grow. The ground cover that held the soil in place was gone. The Plains winds whipped across the fields raising billowing clouds of dust to the skies. The skies could darken for days, and even the most well sealed homes could have a thick layer of dust on furniture. It is important to monitor and maintain soil because it is much easier to ensure soil stakes in good health than to restore soil. Soil takes many years to develop.

4. Share a brief timeline of the Dust Bowl with students through the lens of agriculture and farming practices and direct students to create a simple storyboard or comic of the events shared. If time allows, students can create their own timeline online using Dipity, Timetoast or Capzles (or one of the other resources listed at the end of this lesson plan) with information they researched about agriculture and farming practices. Remind students they are not looking to capture every major event of the Dust Bowl but are looking for example of how farming practices caused the Dust Bowl and influenced it over time.

5. Share the scientist video *Soil #4: Strategies* answering the question, "What are some of the strategies used to improve and maintain the health of soil?" Explain to students that we have explored various examples of how we are dependent on soil. Share images of ways that humans enrich soil. Images include adding organic matter to improve water holding capacity, spreading mulch to retain soil moisture and reduce runoff and composting. Ask students: Which of these is something you have seen in practice in your community? What are some practices you could see being helpful in your community? How could you influence others to put these into practice? How can your knowledge about soil help you to persuade others to use these practices? Consider setting up a Google + Community for students to share classroom service projects around soil conservation. http://www.google.com/+/learnmore/communities/

Part 4: Extend

1. Explain to students that worms are valuable to soil because they are decomposers and recycle nutrients in the soil. Worms eat soil and digest the organic matter for nutrients. The organic material came from plants and animals that lived in the soil. Worms spread their nutrient-rich waste, developing new soil in which new plants can grow.

2. Create a composting bin with your students to observe this process in action. The Environmental Education for Kids website has directions and material lists for you to get started. http://dnr.wi.gov/org/caer/ce/eek/earth/recycle/compost2.htm

Part 5: Evaluate

Have students self-evaluate for:

- Their understanding of how humans rely on soil by accurately describing examples through their tic-tac-toe sentence summarizer.
- The connections students made between the different values of soil as a natural resource and their importance.
- The storyboard or comic illustrating and describing an example of why it is important to monitor soil health.

Specific questions:

1. Describe the role of soil as a valuable natural resource.
2. Explain the relationship between humans and soil.
3. List two reasons why it is important to monitor and maintain the health of soil. Use the Dust Bowl as an example.

Additional Resources and Further Reading:

The Dust Bowl

- http://www.pbs.org/kenburns/dustbowl/
  Includes several interactive resources to explore The Dust Bowl.

Soil Science Education

- http://neptune.gsfc.nasa.gov/bsb/
  Information about soil, soil science and the soil's role in our everyday lives.

Resources to support Timeline Development

- Dipity - http://www.dipity.com/
- Timetoast - https://www.timetoast.com/
- Capzles - http://www.capzles.com/
- Meograph - http://www.meograph.com/
- Timeglider - http://timeglider.com/
- Time Rime - http://www.timerime.com/

The Role of Soil in Supporting Structures

- http://www.sciencebuddies.org/science-fair-projects/project_ideas/Geo_p010.shtml#procedure
  Complete procedure to test the level of compaction of soil at different locations