Down and Dirty

Grade: 6 | **Time:** (2) 45-60 minute periods

Standards:

Georgia Performance Standards in Science
S6E6. b, S6E5.h,i,j

Next Generation Science Standards
ESS3.A, ESS3.C, MS-ESS3-1, MS-ESS3-3, MS-ESS3-4

Supplies in kit:

Soil donuts/mud pies
16 clear non-plastic cups per class

Bring your own:
- soil samples from very sandy to heavy clay
- source of water (tap, spigot or spray bottles)
- trowels and zip top bags for soil collection
- gloves (optional/ 1 pr per student)
- hand washing facilities
- newspaper

Teabag citizen science
per group (8 groups of 4 students)
1 unused pyramid-shaped teabag

Bring your own (for each group)
- Timer (can be found on most cell phones)
- Rulers (to measure 8 cm planting depth)
- Trowel, spoon, stick or digging tool

Soil texture
per group (8 groups of 4 students)
samples of three local soils (1 set per group)
OR three artificial "soils" made of pebbles, sand, clay

Permeability of soil
1 rubber band per student
1 soil test kit (N-P-K-pH) per group of 4 students

Bring your own:
- 2 uniform size water containers per group of 4
- 2 small pieces of cloth per group of 4
- 1 timer or cell phone per group of 4

Garden Connection:
Students will collect and characterize soils from the schoolyard and the garden; test soils; and amend accordingly. Students will also implement a soil conserving practice in the school garden and/or create a compost heap.

STEM Connection:
Students will design and build a composting system and analyze the resulting soil.

Overview

Students will investigate the structure and characteristics of soils in the schoolyard and in the garden based on texture, composition, nutrients, and fertility.

Essential Questions

What kind of soils are in our garden or schoolyard? How can different soils be characterized? What can we do to improve soils for gardening?

Engage

Students will experiment with various soils to discover that different soils have different properties depending on their composition.

Explore

Students will identify soil types using a feel test, conduct a permeability test, make their own soil profiles, and test soils using a soil test kit.

Explain

Students should characterize soils in the schoolyard and argue from evidence to defend their conclusions about texture, composition, nutrients, and fertility. Students should determine what amendments should be made to the soil in order to grow a specific plant or crop.

Environmental Stewardship

Students will implement a soil-conserving or amendment practice in the school garden, according to soil test results.

Evaluate

A rubric is provided for assessing student performance expectations. Discussion questions are also provided.

Extend

Students may create a compost heap to divert food waste from the landfill and contribute to soil fertility.

Standards

GEORGIA PERFORMANCE STANDARDS IN SCIENCE

S6E6. Students will describe various sources of energy and with their uses and conservation

b. Identify renewable and nonrenewable resources.

S6E5. Students will investigate the scientific view of how the earth's surface is formed

h. Describe soil as consisting of weathered rocks and decomposed organic material
i. Explain the effects of human activity on the erosion of the earth's surface
j. Describe methods for conserving natural resources such as water, soil, and air

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas

ESS3.A: Natural Resources

Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

ESS3.C Human Impacts on Earth Systems

Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Performance Expectations

MS-ESS3-1

Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes

MS-ESS3-3

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

MS-ESS3-4

Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems

TEACHER BACKGROUND INFORMATION

For a quick refresher on ESS3A Natural Resources, please check out the Bozeman Science short film on this disciplinary core idea: http://www.bozemanscience.com/ngs-ess3a-natural-resources/

And for a refresher on ESS3C, check out this Bozeman Science short film:
http://www.bozemanscience.com/ngs-ess3c-human-impacts-on-earth-systems/?rq=ess3c

Resources

- Compost Maturity Tests from Florida's Online Composting Center: http://sarasota.ifas.ufl.edu/compost-info/tutorial/compost-maturity-test.shtml
- Fertilizing Info: http://extension.missouri.edu/publications/DisplayPrinterFriendlyPub.aspx?P=G6956
- Nourishing the Planet curriculum, posters: https://www.nutrientsforlife.org/for-teachers
- Have students visit The Microbe Zoo to learn about the microbes in compost and soil: http://commtechlab.msu.edu/sites/dlc-me/zoo/
- Earth Science Teachers' Association, (1993) Teaching Primary Earth Science, No. 3, Soil, forming part of Teaching Earth Sciences Vol.18. Original Soil Donut web site: http://www.earthlearningidea.com/PDF/153_Soil_doughnuts.pdf

LESSON PROCEDURES

Engage

Soils are a precious resource on which we all ultimately depend for our food supply. Understanding the structure and nature of a soil can lead to better management techniques. Students will experiment with various types of soils in the Soil Donuts and Mud Pies activity, to discover that soils are made of different ingredients and have different characteristics.

Soil Donuts and Mud Pies

1. Have students collect a variety of soil types ranging from sandy to heavy clay, and dampen each sample with water.
2. Place the soil samples at stations around the outdoor classroom (or indoors).
3. Divide students into teams of fours and establish a direction in which they will rotate among the stations.
4. At each station, students will handle soil to determine what type it is, in the following manner:
   - Take a handful of soil and wet it so that it begins to stick together without sticking to the hand.
   - Make a ball about 3 cm diameter between your hands and put it down. If it falls apart it is sand.
   - If the ball sticks together, pick it up and roll it into a sausage shape 6 – 7 cm long and set it down. If it will not remain in this form when set down, it is loamy sand.
   - If it remains in the sausage shape, continue to roll until it reaches a 15 – 16 cm snake shape and set it down. If it will not remain in this form, it is sandy loam.
   - If it remains in the snake shape, try to bend it into a half circle while it remains on the table. If it doesn't remain in a half circle, it is a loam.
   - If the snake will remain in a half circle, form it into a full circle. If it will not stay in a full circle, it is heavy loam.
   - If the circle snake forms slight cracks, it is light clay.
   - If the circle snake does not have any cracks, it is a clay.

   Identification of soils using this method was first described by Coche and Laughlin (1985): (http://www.fao.org/docrep/field/003/AC172E/AC172E04.htm)
   A full description and chart can be found at http://www.earthlearningidea.com/PDF/153_Soil_doughnuts.pdf

Tea Bag Index Citizen Science Project

Students will participate in a real-world study of the decay rates of various soils, help create a global soil map and contribute to research on the carbon cycle by participating in the Tea Bag Index (TBI) citizen science project. In brief, students will follow these steps:

- Provide 1 unused Lipton green tea and / or Rooibos pyramid-shaped tea bag per group of four students
- Ask each team to identify places in the schoolyard where different types of soils might be found.
- Bury each tea bag approximately 8 cm below the surface with label above the surface. Tea bags should be buried separately from each other.
- Mark the locations where tea bags or buried (or record GPS locations). Be careful not to mark the tea bags in a way that creates tripping hazards.
- Dig up the bags after three months.
- Dry the tea bags in a warm, sunny place.
- Tap the soil off the outside of the tea bags.
- Remove what is left of the yellow label but leave the string.
- Weigh each tea bag separately.
- Complete this form and upload the data: http://www.decolab.org/tbi/data/index.php

The full protocol can be found at the DecoLab web site: http://www.decolab.org/tbi/protocol.html

Explore

After students identify soil types based on composition, they will investigate the properties of different soils. Divide the class into teams of four to complete the following activities.

1. Have students evaluate soil types using a feel test. Rub moist soil between fingers. Sand feels gritty. Silt feels smooth. Clays feel sticky.
2. Conduct a soil permeability test.
   a. Students can test the rate of permeability by comparing equal amounts of sandy soil to clay soil. Cut in half two plastic liter bottles, using the tops to make funnels. Use a cloth or paper towels to cover the funnel holes.
   b. Put only one soil type in each funnel. (Do not mix soils)

c. Pour equal amounts of water onto each sample of soil. Compare the time the water takes and amount of water that pass through each sample.
d. Have students draw conclusions about how different soils can dry out quickly, become water-logged, or are effected by erosion.

3. Make your own Soil Profile from the garden by taking a core sample of the soil (or removing dirt from an 18" deep hole and observing the sides of the hole). Have students draw layers with colored pencils and compare it to other soil profiles in different climate regions, using internet pictures.

4. Conduct a do-it-yourself soil test for nitrogen (N), potassium (K), phosphorus (P) and acidity (pH), following directions provided with the soil test kits.

5. Collect a soil sample using the following protocol and send it to your state university's agricultural extension service for analysis. Depending on the state, this may be free or may cost up to $30.
   1. Get a trowel and a bucket. Be sure neither is rusty or made of galvanized (zinc-coated) metal, which could skew your results.
   2. Scrape mulch and leaf litter from the soil surface. Dig out a wedge of soil about 6 to 8 inches deep, and set this wedge aside.
   3. Now dig out a half-inch piece of soil from the hole and pour it into your bucket.
   4. Repeat steps 2 and 3 at least a half-dozen times in different parts of the garden so that the soil sample represents your whole garden when mixed.
   5. Use your trowel to mix the soil together thoroughly.
   6. Fill the soil sample bag or container with the mixed soil, complete the paperwork and mail it all off to the lab.

Get your soil tested at an extension service office as close to home as possible, so that the recommendations you receive make sense for your climate and soil. (How to Get an Accurate Soil Test. (n.d.). Retrieved December 8, 2014, from http://www.organicgardening.com/ learn-and-grow/how-get-accurate-soil-test)

Explain from Evidence

Students should characterize soils in the schoolyard and argue from evidence to defend their conclusions about texture, composition, nutrients, and fertility. Students should determine what amendments should be made to the soil in order to grow a specific plant or crop, based on soil test results.

Environmental Stewardship

Students will implement a soil-conserving or amending practice in the school garden, according to soil test results.

Evaluate

A rubric has been provided for assessment of performance expectations. Here are discussion questions:

1. What makes one soil different from another?

In the natural environment soils are made up of mineral materials grouped into three main size classes: sand, silt and clay. These different size fractions determine the way a soil feels (or its texture).

2. How is soil formed?

Soil is formed as rocks are weathered or broken down by wind, water, temperature changes and geological movements and decayed organic materials.

3. Why is soil texture important?

Soil texture determines its permeability and nutrient retention. Clay's smaller particles hold more nutrients but is less permeable; sand is very permeable, but does not retain nutrients.

4. What is the best type of soil for gardens?

Loam, a mixture of sand, silt and clay.

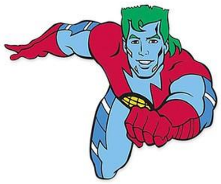
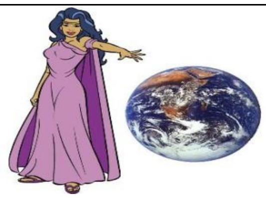
Extend

Students may create a compost heap to divert food waste from the landfill and contribute to soil fertility.
http://extension.missouri.edu/publications/DisplayPrinterFriendlyPub.aspx?P=G6956

Down and Dirty

Grade: *6* | ***Time:*** *(3-5) 50 minute periods*

Name: ____________________ ***Date:*** ______________________ ***School:*** _______________________

Level of Mastery Benchmark or Performance Measure	 EMERGING Not yet proficient 1 point	 COMPETENT Partially proficient 4 points	 PROFICIENT Mastered task 5 points	TOTAL POINTS
Sorting out soils; Estimating soil texture	Recognizes that soil is composed of different ingredients.	Identifies different soils based on their ingredients and understand that a change in ingredients changes the soil type.	Identifies different soils and properties based on its ingredients and can predict changes to soil types based on changes in ingredients.	
Soil Permeability: The Great Soil Race	Tests the permeability of a range of soils, but cannot put them in order of permeability, or explain why some soils are more permeable than others.	Tests the permeability of a range of soils, puts them in order of permeability, but cannot explain why some soils are more permeable than others.	Tests the permeability of a range of soils, puts them in order of permeability, and explain why some soils are more permeable than others.	
Soil Profile	May recognize primary soil types, but are not able to represent layers in soil profile.	Order card sequence with 80% accuracy, identifies the major soil layers & recognizes differences in soil layers. Cannot draw conclusions based on climate, vegetation and rock type.	Has correct card sequence, identifies the major soil layers & realizes that soil layers vary based on climate, vegetation and rock type.	
Soil Testing	Tests soil, but cannot accurately interpret results.	Can test soil and interpret results, but cannot specify amendments to change.	Can accurately interpret test results and specify amendments needed to reach appropriate P-N-K-pH levels for intended plants.	