Dirt Investigations

Objectives:

- Students will be able to explain the importance of soil.
- Students will be able to describe the similarities and differences in 3 samples of soil.
- Students will be able to explain one field method used to test for water retention.
- Students will be able to define soil porosity.
- Students will be able to describe the steps a scientist uses when conducting an experiment in the lab or in the field.

Vocabulary: soil, porosity, silt, sand, clay, soil pores, scientific method

Grade Level: Grades 2-6

Time Allotted: 45 minutes – 1 hour

Standards Addressed:

Connections to Next Generation Science Standards:

Science & Engineering Practices: Asking Questions & Defining Problems, Planning & Carrying out Investigations, Analyzing & Interpreting Data, Engaging in Argument from Evidence

Disciplinary Core Ideas: ESS2.A, ESS3.B, ESS3.C, ETS1.B, ETS1.C, PS3.A, PS3.B

Crosscutting Concepts: Cause and Effect, Energy and Matter, Scale, Proportion and Quantity

Connections to the GSEs

ESS1 (K-2) 1a, 1b, 2a, 6a, PS1 (K-2) 1b, 2a, 3a**,** ESS1 (3-4) 1a, 1b, 1d, 2a, 6a,
PS1 (3-4) 3a, 3b, 3c, ESS1 (5-6) 2a, Scientific Method

Cross-curricular Connections: lesson: Math, extensions: Arts, Language Arts, History

Materials Needed: apple, knife, 10-15 spoons, science journals & pencils
3 different types of soil (ex. potting soil, play sand & clay kitty litter)
bins for soil samples, glass jars, funnels, coffee filters,
measuring cups, beakers, balance scale, hand magnifying lenses

Procedures:

1. Begin discussion of why soil is so important. What is SOIL?
    a. Explain that soil is one of the most important yet least appreciated natural resources.
    b. Soil is the loose top layer of our planet's crust.
    c. Soil is where plant life can grow and it provides homes for animals.
    d. Soil absorbs water, and acts as a filter for our groundwater.
    e. Soil also plays an important role in nutrient cycling for our crops, and provides support for our buildings.
    f. Ask students what the four basic materials are that make up the earth. Write these on the board: soil, rocks, water and air.

2. Conduct a demonstration: *How Much Soil is There?*

a. Show students an apple and explain that it represents the earth.
b. If the earth was an apple, about 75% would be covered in **water**.
   Cut up an apple into quarters and ask students, how much is 75%? Discard 3 pieces.
c. The remaining ¼ apple represents **dry land**.
d. Half of the dry land on earth is **desert**, **tundra**, or **mountains** where it is too hot, too cold, or too high to have productive soil.
   Ask students, how much do we cut next? How much is left? Cut up half of the quarter and toss half away which leaves 12.5% of the original apple.
a. Of the remaining 12.5%, 40% is very limited by terrain, fertility, excessive rainfall, or is too rocky, steep, shallow or poor to support food production.
   (Ask students how to figure out how much to cut this time. Cut away 40% of the remaining apple).
b. Ask students, how much is left? This leaves **7.5% of our soil on earth** considered healthy and useable for human and animal food production.
c. Unfortunately, much of this land is under housing developments, schools, shopping centers, landfills, or is polluted.
d. So it is amazing that we are even able to support our human population on the little fertile soil available. Maybe we will start to look at soil differently now!

3. Next the class will conduct an experiment on Soil Porosity:
   How Much Water Can Soil Hold?
   Explain soil porosity.
   a. Soil has pores (holes) in it. This allows animals and other small organisms to live in the soil as well as plants to grow and root in the soil.
   b. In addition to animals and plants, the soil pores allow both water and air to be in the soil (which those animals and plants need to survive!).
   c. There are large pores (called **macropores**) and small pores (called **micropores**).
   d. Which ones do the students think allow more room for air and water? (macropores)
   e. And which ones do the students predict will allow water to move faster through them? (macropores)
   f. If the soil only had macropores (the big holes), then water would run right through the soil and none would stick around long enough so that plant roots could absorb the water.
   g. This is why micropores (the little holes) are important. Micropores are small enough that they can hold onto the water coming into the soil. What causes water to come into the soil? Rain or other forms of precipitation.
   h. Different types of soil have differing amounts of macro- and micro-pores. So water drains through different types of soils at different rates.

4. That is what our experiment today is about: how fast does the water drain through the soil, and how much water does the soil hold onto?

5. The students will use the scientific method to conduct this experiment. The scientific method in this experiment will consist of these basic steps:
   a. Observation
   b. Questions
   c. Hypothesis/ Predictions
   d. Testing

e. Results

6. OBSERVATIONS:
    a. Students will observe 3 bins of soils at their tables (sand, potting soil, & clay), labeled Sample A, Sample B and Sample C.
    Do not tell the students what each type is.
    b. Students should investigate by looking, feeling, and even smelling to make observations about the samples and then write down their observations.
    c. Explain that the scenario is we are building a house and then want to plant a garden and need to know what types of dirt/soil will be the best.
    d. What factors are important for building a house? Things like drainage are important so that our basement does not flood in the rain.
    e. What factors are important for planting a garden? Drainage is important, but also the ability of the soil to hold onto some of the water so that it is available for the plants.

7. QUESTION: See if the students can come up with a question that will address our concerns. It will probably be some variation of this basic question:
<u>Which soil sample will retain the most amount of water (Sample A, B, or C)?</u>

8. HYPOTHESIS/ PREDICTIONS:
    a. Students should then formulate their own hypothesis (educated guess) about the answer to that question, and write it in their journals.
    For example: I think that sample B will hold the most amount of water because….
    b. Students will then make predictions about what will happen when they conduct the test. They write this next to their hypotheses.
    For example: When we pour the water through sample B, half will be retained by the soil, which will be measured after the water stops dripping.

9. TESTING:
    a. Ask the students how they will be able to tell which soil sample holds the most water? What can they measure? There are two ways that they can measure the amount of water: measuring the **volume** (review with them what volume is) and measuring the **weight**. If time permits for this experiment, it would be interesting for the students to do both measurements.
    b. Students working in small groups will be given a spoon, funnel, three glass jars, a measuring cup, a beaker, water, coffee filters, and a scale for weighing their samples. These materials will be needed to conduct the experiment.
    c. Students will spoon a sample of each soil type into a measuring cup until it reads 100ml, then pour this 100 ml of soil into its own coffee filter (1 filter for each type of soil —sand, potting soil, and clay). This 100 ml of soil will be weighed using a balance scale. Make sure students record the initial weight of the soil in their science notebooks.
    d. Each filter with its 100 ml of soil should then be put in a funnel and set on top of an empty jar.
    e. Students will then be measuring out 100ml of water in a beaker. If they want the weight of this water, how will they take into account the weight of the beaker? They need to weigh the empty beaker *first*, record its weight, then weigh the 100 ml of water in the

beaker, and record that weight. The difference in weight between the beaker + the water and the empty beaker is the initial weight of the water.

f. Next they take the 100 ml of water and pour it slowly and steadily through each of the soil samples, one sample at a time.
g. Students will record the flow rate of water through each type of soil by noting how long it takes from the moment the water is poured over the soil until the water coming out of the soil into a jar reaches a slow drip (less than one drip per second).
h. Finally, the students will record how much water was retained by each soil type by measuring volume and weight.
i. The volume is measured by subtracting the amount of water that passed through the filter (they pour what is in the glass jar under each of the three samples back into the beaker to measure it) from the total amount of water used (100ml).
j. The weight is measured by first adding the weight of each dry soil sample to the weight of the 100 ml water that was calculated at the start of the experiment. Then, for each sample, subtract the weight of the dry soil + the water from the weight of the wet soil in the filter.

10. RESULTS: Students will share their team results, discussing the methods they used as well as any interesting findings.
    a. What are their conclusions about the soil samples?
    b. What soil type would be the best and the worst to build upon if we were worried about flooding?
    c. What soil type would be the best for growing plants in a garden?
    d. Typical results may include that sand lets water pass through quickly because the solid particles are large and there are many air spaces around the particles. Sand also does not retain much water. The clay has the slowest flow rate and holds the most water because the particles are so small.
    e. Explain why we would use more sand around a basement due to its properties of large pore size (more macropores) which should lead to good drainage.
    f. Explain that many gardeners mix different types of soil into the ground before planting to ensure good drainage AND good retention of some water for the plants.
11. Discuss how the soil properties determine how we use the soil. For example, clay is used for cat litter, sand is used for a sand box, and potting soil is used to plant our garden or houseplants. Can students think of any other uses of different soils?

12. Take the students on a short outdoor hike to assess different soils found near the school. Compare the garden soil to the schoolyard edge soil, and compare the soil under deciduous trees to the soil under conifers if those trees are in the schoolyard. Can the students find differences and similarities? Students should be encouraged to explore the soil by feeling it (and even smelling it!) in addition to looking at it under magnifying lenses.

13. Repeat this soil porosity test (also known as a percolation test) on the garden soil, and other spots in the schoolyard. Students can collect soil from various different locations. These soil samples will then be brought indoors to test. Students will then be able to make some conclusions about our schoolyard soils and what is important for the garden soil.

Extensions:

1. Arts Extension

Conduct a different kind of a test on the different types of soil: a sculpture test!
Let students experiment with making shapes out of clay, silt (like potting soil) and sand.
Which soil keeps its shape the best?
Does adding water affect the ability of the soil to hold its shape?
How does this affect the decisions people make about what materials to build things with or where to plant their gardens?

2. Language Arts/ History Extension:

Ask students to use the results of the soil tests conducted around the schoolyard to recreate the story of how the land has changed over the past 100, 200, even 300 years. Challenge them to write a story about a Native American family or a colonial family that may have lived on this site. Here are some prompts that may help them get started:

*Where would they have had their home?
*Where would they plant their food crops?
*Would they have had play area? Which place was best for that?
*Would they have been able to make pottery with the soil?