The Dirt on Soil

Summary

At the end of this activity students should understand the source and the process for the formation of soil, the different types of soil, and the components of soil.

Materials

Dirt
- Soil journals pdf
Colored pencils
Scissors
Glue
Red and green card for each student
Rocks
Cake Mix
Bowl
Eggs
Oil
Water
Mixer
Containers (1 per group) of sediments (small pieces of rock and minerals, gravel, etc.)
Containers (1 per group) of leaf mold
Overhead projector
Transparency of circle graph pdf
Containers of garden soil with a worm and plant
Magnifying glasses
Paper towels
3-pint jars
Marbles
Beans
Rice
Containers of sand, silt, and clay soil
Containers of sugar, flour, and modeling clay
Containers of water
Straws
Straws or tubes of different diameters
Raindrop shapes cut from blue paper
Funnels
Paper cups
Measuring beakers
Cheesecloth
Plant growing in a pot
Clear plastic cups
Scotch tape
Grass seed and beans

Soil Particle Size and Texture

3 jars:

Marbles: Sand
Beans: Silt
Rice: Clay
Containers of three main soil types:
Sand
Silt
Clay
Containers of sugar, flour, and modeling clay
Container of water

Additional Resources

Books

- *Dirt*
  , by Steve Tomecek; ISBN 0-7922-8204-3
- *Life in a Bucket of Soil*
  , by Alvin and Virginia Silverstein; ISBN 0-486-41057-9. This book contains information on all the different living creatures who make their home in soil.

Media

- *Dirt: Secrets in Soil*
  video and lesson plans, Utah Agriculture in the Classroom Utah State University 435-797-1657 http://extension.usu.edu/aitc/
  Sprout and Grow Window and RootVue Farm: These allow students to actually see roots growing beneath the soil. Available at teacherdirect.com

Background for Teachers

This activity is set up to do demonstrations and experiences with the whole class doing them together. You need to break this activity up and do one section each day rather than trying to do it all at once. You can also set this activity up into centers and have the students rotate through them with an aide or volunteer helping with each one.

There are a number of things that need to be prepared ahead of time for this activity

Assessment will be ongoing throughout the activity. Use the *Red Card/Green Card: Stop Me If I'm Wrong* assessment strategy. Give each student a red card and a green card. After each section present statements to the students. If your statement is true, they show the green card. If you make a false statement the students need to STOP you by showing their red cards. They then need to decide what was false about the statement and correct it so it becomes a true statement. They then show their green cards again and you can continue.

At the end of this activity students should know the following:

Rock is the parent material of soil. Rock is the source of the inorganic (nonliving) materials found in soils. The rock is broken down into sediments (small pieces of rock and minerals) through the process of weathering. These sediments are a component of soil.

Most soils are formed from sediments that have been moved by erosion-blown by winds, moved by water or glaciers. (Teacher information: Fast moving water leaves behind gravel and sand. Slow moving water and lakes leave behind fine textured clay and silt when sediments in water settle.)

Different types of sediment make different types of soil. Most common soils are a mixture of these three types.

Sand: Large, gritty particles (Feels like sugar)

Silt: Smaller, smooth particles (Feels like flour)

Clay: Tiny particles, sticky when wet, forms hard clumps or clods when it dries (Feels like modeling clay)

The sediments provide structure for plants in the soil. They give the roots something to hold onto.
Air and water are also components of soil. These components are necessary for plants to grow.
The size of the sediments affects how the soil holds air and water.
Soil contains organic material. Living and once living (dead and decaying) plant and animal matter. These organic materials provide most of the nutrients plants need to grow.
Plants can be grown without soil, if they are provided air, water, and nutrients from another source.

Intended Learning Outcomes

1. Use Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning

Instructional Procedures

Invitation to Learn
Read the book *Dirt* by Steve "The Dirtmeister" Tomecek aloud to class.
Instructional Procedures
Make Soil Journals
Formation of Soil

Give students a rock. Tell them their assignment is to turn the rock into soil. Do not give them any more information. Tell them they have 5 minutes to write their plan for turning the rock into soil in their journals. They can use pictures, words, phrases, or sentences.
Show them a cake mix and explain that making soil is similar to making a cake. Think about it...do you just put the box into the oven and presto a cake comes out? What do you need to do? (Add other things, mix them together, put it into the oven and let it bake) Explain that making soil from rocks is a process much like this. You have to add other things, mix them together, and it takes time)
The first step in turning rock into soil is that it must be broken down into sediments--small pieces. (Pass out containers of sediment for students to look at and touch) Access students' prior knowledge about weathering and ask them how rocks can be broken down. Make sure they include wind, water, ice, plant roots, people. Once the rock is broken down it is often moved to a different place. This is called erosion. Access prior knowledge about erosion. What forces cause erosion? (Wind, rivers, runoff, glaciers) The sediments are piled up. Is it soil yet or just a pile of sediment? It's not soil yet...it needs more.
Think about the cake mix again. Pour the cake mix into a bowl. The cake mix is like the pile of sediments. What do we have to do to make this into a cake?
Add eggs and oil
The eggs and oil represent organic matter in the soil. Organic matter is plants and animals, which die and start to decay in the soil. Pass out containers of leaf mold. This is what leaves look like after they have started to decay. Where do you think the parts of the leaves that are gone went? (Into the ground)
So if organic matter gets mixed in with our pile of sediment then they combine and we are getting closer to making soil, just like we closer to turning this into a cake.
Add water
The cake mix needs water. Soil also needs water. Water is a component of soil. Rain and snow seep into the pile of sediments and organic matter.
Mix up the cake mix
Why do we mix up the ingredients? It combines them together and it also adds another important component to the cake. It adds air. That's why you have to mix a cake mix together for several minutes...you need to add plenty of air into it or your cake will look like a pancake!

Soil is the same way. It needs air. That's why we dig or plow or till soil before we plant.

Air is added to the sediments and organic matter over time.

The last thing we need to make the cake is time. You have to put it in the oven and bake it. Soil also needs time. It's not nearly as fast as a cake. A cake takes half an hour. Soil takes hundreds of years.

Serve a piece of cake to each of your students. Ask- "What does your body do with the cake? It takes out the nutrients your body needs--in cake there are lots of carbohydrates, which provide energy for your body. Plants do the same thing. They take the nutrients they need to live and grow out of the soil. They are adapted to just take the nutrients out and leave the other components of soil behind. (*Make sure your students understand that plants don't "eat" soil the way we eat the cake).

Journals: Have the students make a graphic organizer to show a timeline of the formation of rock. It should have at least 4 different steps in the process of changing a rock into soil.

If students are struggling have class brainstorm some ideas together to help them get started, or review the soil formation pages in the book Dirt used for the Invitation to Learn. You could also make the graphic organizer and run copies for the students if you feel they need it.

Assessment: Green Card/Red Card statements (you can add additional statements)

Soil is made from rocks.

Changing rock to soil takes just a few weeks

Composition of Soil

Average soil contains these amounts of the components discussed in Step 1-Show the overhead transparency of the circle graph Inorganic (nonliving) 25% air 25% water Minerals 45% Organic (living/once living) 5% Give each student a copy of the circle graph. Paste them in their journals and complete their own circle graph --fill in each section to show that material (example: water blue drops; air gray squiggles; mineral matter different colored pebbles; organic matter-animals that live in the soil and decaying plants. Extension: You could have students show the same percentages on a bar graph to give them practice with different types of graphs.

Pass out containers of soil containing organic matter, magnifying glasses, and paper towels. Tell students: We're going to examine this soil and see if we can find the different components that make up soil. Which do you think you will be able to see? Will there be any that you can't see? You should be able to see the minerals; they are the pieces of sediments. Rub the soil between your fingers and you can feel the particles. Look for organic matter-living plants and animals, and evidence of once-living things like bits of plants, twigs, leaf, or parts of dead animals. You might be able to tell that there is water by looking at the soil. Soil is darker when it has moisture in it. You can feel the moisture by touching and squeezing the soil, or you can look for dampness on the paper towel-those are all proof of water in the soil. You will not be able to see the air--but look for the spaces between the particles- they are filled with air. Spread the soil out onto the paper towel; examine it with the magnifying glasses. Separate the soil into Non-living inorganic materials: minerals and evidence of air and water and organic: living and once-living (decaying) plant and animals.

Journals: Word Web graphic organizer- Teacher draws a model of web on board or overhead for students to copy into their journals as you discuss the components they discovered as they investigated the soil sample.

Assessment: Red Card/Green Card Statements

Soil is 45% organic material

Soil contains both air and water

Plants and worms are examples of inorganic, non-living material in soil

Soil is 45% mineral matter

Soil Particle Size and Texture

There are hundreds of different types of soil in the world, but all those types of soil are combinations of the three main types of soil: sand, silt, and clay.

These types of soils are identified by the size of the particles or pieces of mineral matter in them. These jars (show the marbles, beans, rice) can help us compare the particle size of the different types of soil.

Sand: Sand has large particles like these marbles. Because these particles are large they fit together loosely. You can feel the particles in the sand, it feels like sugar. Open the container of sugar and take a little bit of it. Rub it between your fingers. What does it feel like? Now open your container of sand. Take a little bit of it. Rub it between your fingers. Does it feel like the sugar? That is because you can feel the individual particles. What words would you use to describe how it feels? (Rough, gritty, etc.) This tells us the TEXTURE of the soil. Take a few drops of water and add it to the sand in your hand. What does it feel like when it is wet?

Repeat with the jar of beans, flour, and silt. Silt has smaller particles, they are more finely textured. Silt feels smooth. It often sticks to your hands. Silt is found near lakes and mouths of rivers, or where soil particles have been carried by slow moving water.

Repeat with the jar of rice, modeling clay, and clay. Clay has the smallest particles. They pack very closely together so there is almost no space between them. Clay feels fine and slippery. When it's wet it feel slick. When it dries it packs so closely together that it is almost like cement. The dirt clods in your garden that are really hard to break apart most likely have a lot of clay in them.

Optional: Make a sedimentator. You need a clear plastic jar with a lid. Put in one cup of average soil and then fill with water until jar is about 2/3 full. Shake jar vigorously for 1-2 minutes. Let it sit overnight. The sediments will settle out of the water into layers of different soil types. The sand will settle first and be the bottom layer because of its large particles. Silt particles will follow and form the second layer. Clay sediments settle last, they might even take longer than 24 hours so keep observing the jar for a few days. The organic matter will float on top of the water.

Journals:

Particle Size: Give students patterns of jars and have them trace and cut out three jars and glue them into their journal. Label each jar: sand, silt, and clay. Draw particles to show each type of soil. Remind them that the bigger the particle, the bigger the space between it. Have them look at the jars of marbles, beans, and rice to see the difference in the size of the spaces.

Texture: Have them write the name of each type of soil using block letters that represent the texture of that soil. Example: Sand--use pointy, rough looking letters, spread the letters far apart. Fill in the letters with a texture pattern that represents that soil. Choose one or two words that describe the texture of that soil and write them underneath the name. Cut the name and words out and glue into journal.

Assessment: Red Card/Green Card Assessment Statements

Sand is rough and gritty and has large particles.

Clay has the largest particles.

Silt feels smooth like flour, it has medium sized particles.

Sand particles pack very tightly together with no space between them

Clay feels slippery when its wet and dries rock hard

Air in Soil

Give each student a straw and give each group a container of water. Tell them to blow bubbles in the water. Ask what made the bubbles? (Air) Bubbles are evidence of air. Challenge class to think of other examples of bubbles being evidence of air. (Fish tanks, scuba divers, bubblegum bubbles, bottles of bubbles, etc.)

Give each group a measuring beaker, a cup of soil, and a cup of water. Pour the water slowly over the soil. Watch very carefully for bubbles. That is evidence of air in the soil. Where is the air in the

soil? (Fills the spaces between the particles)
Which types of soil, sand, silt, or clay do you think has the most air? Which has the least air? Why?
Journal: How can you show that there is air in the soil? Could you add anything to the particle jars to show that there is air? Have them color in the spaces between the particles gray and then make a key on the page to show that gray = air.
On the next page have them do a drawing of each type of soil to show how much air would be in it. Do a circle for each type of soil. Have them fill the circle showing the particles and air in each type of soil. Label each circle.
Assessment: Red Card/Green Card Assessment Statements:

- There is no air in soil.
- Air fills in the spaces between the particles in soil.
- The more tightly packed the particles the more air there will be in soil.
- Sand has the largest particles so it has the largest spaces and the most air.
- Clay has the smallest particles so it has the most air.

Water in Soil

- Get three different size (diameter) straws and tell the class that you are going to have a race. Choose three students; give each one a straw and a cup of water. Tell the class that the race is to see who can suck all of the water out of their cup the fastest.... have them predict who they think will win and why. Conduct the race.
- Explain that water moves differently through different types of soils. Water moves through the air spaces, so the more and bigger the air spaces are, the more rapidly water can move through it, just as the water moved more quickly through the larger tube.
- Do "Pick a Path" activity to demonstrate: (from Dirt: Secrets in Soil page 43 Utah Agriculture in the Classroom Utah State University)
- Remind students what they learned about the particle and space size in each soil type.
- Divide the students into four groups. Assign each group one of the following titles: water, sand, silt, and clay.
- Give each member of the water group a raindrop cut from blue paper.
- Have the sand group stand together so that just their fingertips are touching. Their arms should be extended straight out.
- Have the silt group stand together with their elbows touching.
- Have the clay group stand together with their shoulders touching.
- Tell the water group that their job is to make their way through each soil group. Have them start with the sand. Discuss the results. Repeat with the silt and clay. Have class come up with a statement about how water moves through each type of soil.
- Do a demonstration with actual soil samples. Invite students up close so they can observe closely. You need:
    - A container of water and three paper cups
    - 3 measuring beakers
    - 3 funnels (you can use tops of 2 liter pop bottles) covered in cheesecloth
    - Sample of each soil type: sand, silt, and clay
- Place funnels on top of measuring beakers; place one soil sample in each funnel. Do not pack them down. Slowly pour a cup of water simultaneously into each of the soil-filled funnels. Watch to see if water soaks into the soil quickly or if it pools on top. Time for 1 minute and compare how much water has passed through the soil into the beaker.
- Set timer for 4 more minutes. At the end of 4 minutes (total time of 5 minutes) Compare again. Discuss results with class.
- Journals: Write a simile statement about how water moves through each soil. Draw a drop of

water for each soil and illustrate to show how it moves through that soil.

Example: Water moves through sand like a cheetah running.

Then draw the water drop to look like a cheetah. (Other possibilities: a jet plane, a racecar, a rocket ship, etc.)

Silt: The raindrop could be a trotting horse, or a person jogging, or a car driving through a neighborhood.

Clay: The raindrop could be a tortoise or a snail.

Ask students if they think that the water in soil will stay forever or if it will leave. Leave the soil uncovered until the next day. Have students check for moisture content again. Ask them why they think the soil is drier and what caused it. Review evaporation from the water cycle curriculum.

Assessment: Red Card/Green Card Assessment Statements:

Water moves through all soils exactly the same.

The bigger the particles the more quickly water will move through soil.

Water moves through the spaces between particles.

Water moves quickly through clay soils.

Water move quickly through sandy soils.

Organic Matter in Soil

Look back at the samples of soil that you separated into organic and inorganic materials, and at the word web graphic organizer in your journal. Review what types of things are organic matter.

Discuss: Why is organic material so important in soil? The organic material is what provides the majority of the nutrients that plants need. Dead and decaying plant and animal material provide fertilizer to the soil. Without organic matter the soil would not be fertile and plants would not grow well in it. This would be like you trying to live and grow without food. Organic materials provide food for plants.

Journal: Life in Soil (2 pages- Blacklines in appendix)

Give each student a copy of the "Life in the Soil" outline and a copy of the Is Organic /Is Not Organic worksheet. Cut out the Life in Soil outline and glue it into their journals.

Have them look at each item on the Is Organic/Is Not Organic. If they agree that is a correct example of organic matter in soil have them cut it out and glue it onto the Life in Soil page.

Assessment: Red Card/Green Card Assessment Statements:

Organic means the non-living matter in soil such as minerals, air, and water

You can find both living and once-living, organic matter in soil.

Pieces of twigs and leaves are examples of once living material in soil.

Rocks are organic matter.

Dead and decaying animals are once-living organic matter.

Organic materials provide nutrients or food for plants to live and grow.

How Do These Components of Soil Affect Plant?

Show the class a plant in a pot. Make sure the plant has lots of roots. Ask the class what soil has to do with plants. Review that soil is important because all life depends on the soil. Plants need the soil to grow and animals eat the plants.

Carefully take plant from pot and shake off some of the soil so class can see the roots. The roots are the part of the plant that grow down into the soil. What do the roots do and how do they relate to the soil? Soil particles keep the roots in place and help hold the plant up. The water, air, minerals, and organic matter in the soil are all used by the plant to live and grow. Plants take these things from the soil through their roots.

Make sure you reinforce the concept that plants don't use up the soil; they just use the components of the soil.

What would happen to plants if there were too little or too much of the different components of soil? Use creative movement to show these situations. Act like a plant:

...in clay type soil that holds too much water so there is very little air, and then dries rock hard. (Help, we're drowning, there's no air, are roots are getting squished, they can't bring us any food)
...in sandy soil that has large, loose particles where the water flows through too quickly for the plants to use it. (Help we're dying of thirst, we're falling over)
...in soil that has no organic material so it has no nutrients (Help, we're starving to death, there's nothing to eat, we're small and weak because we have no food.)
Journal: Have students draw and label the soil and plants from each situation they acted out in their journals.

Assessment: Red Card/Green Card Assessment Statements:

Soil is necessary for all life on earth.
If there was no soil on earth we would still be able to live
Plants take air and water from the soil through their roots
Plants grow best in soil that has no organic material in it
Dead and decaying plants and animals add nutrients and food for the plants to the soil

Extensions

The What? No Soil? Mystery! We have learned that soil is necessary for plants to live and grow. Do you think that plants could ever grow without soil? What would you need to do? You would need to find some other way to give them the things like air, water, and nutrients that they usually get from the soil. You would also have to find a way to support the plants without having their roots held in soil. Scientists around the world are studying ways to do this. Discuss why we would want to be able to grow plants without soil.
We're going to do an experiment and see if we could start to grow plants without soil--maybe you can grow up to be a scientist and work on this idea to help save our planet's resources.
Give each group 2 clear plastic cups. Have them moisten the inside of one cup and sprinkle grass seed on the sides and bottom of the cup. Then give them a paper towel and have them moisten it. Carefully fit the paper towel inside the cup, try to disturb the grass seed as little as possible. Place 2 or 3 beans on the paper towel. Take half of another paper towel, moisten it and carefully place it on top of the beans. Put the second cup upside down on top of the first cup and seal them together with tape. Put the cups where they will get sunlight. Observe them and watch for signs of plants growing. The grass and beans should start to sprout within 2-3 days. Ask students what they think will happen if they leave the grass just in the cup. The grass will eventually die because it cannot get the nutrients it needs. So plants can grow without soil but you need to find a way to give them nutrients.
Challenge your high level students to do some research on their own, and share with the class ways scientists are working on solving this problem. These methods are called hydroponics. They could also research plants called epiphytes that grow on other plants. The website kidsgardening.com has information on this presented in a child friendly manner.
Integration with language arts: Write similes for each type of soil:
Sand is as rough as a scrub brush.
Silt is as smooth as silk.
Clay is as slippery as wet soap
.
Or couplets:
Sand is gritty, loose, and dry
It hurts when it gets in your eye!
Silt is soft, powdery, and fine
If it's in your garden, you won't whine
Clay is slick when it's wet

But when it's dry, it's hard you bet

Family Connections

Do a Soil Treasure Hunt activity. Ask students to bring in samples from their yard or neighborhood that they think are sand, silt, or clay.

Ask students to look for areas in their neighborhoods where plants grow well and areas where they don't. Have them bring in soil samples and compare them to see if they find out why.

Assessment Plan

Red Card/Green Card: Stop Me If I'm Wrong statements after each section.

Teacher observation of activities, discussions, and journals

Final Assessment: How Much Do You Really Know About Soil.

Bibliography

Research Basis

Krueger, A., &Sutton, J. (2001). *EDThoughts What We Know About Science Teaching and Learning*. (84)

Hands on experiences help students make meaning about scientific phenomena and help students move from more concrete to abstract levels of thinking. Ongoing learning assessment with timely, focused feedback helps students attain deeper understanding.

Ruis-Primo, M.A., Li, M., Ayala, C., and Shavelson, R.J. (1999). *Student Science Journals and the Evidence they Provide: Classroom Learning and the Opportunity to Learn*. (Paper presented at the meeting of National Association for Research in Science Teaching. Retrieved 1/4/2007 from http://www.education.ky.gov

A study of California fifth-graders, which looked at whether journals were an effective way of assessing learning from inquiry, based science lessons. Results showed a strong correlation between student performances on journal entries with their achievement. Students with low journal scores tended to have poor understanding of science concepts. Journal writing can be a valid way to demonstrate science achievement.

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