

What is Below Your Feet? 4th Grade Lesson Focused on the Make-Up and Formation of Soil

Lesson Overview:

This lesson is designed to engage 4th grade students with decomposition and soil formation. To prepare students for this lesson, read the “Explore” portion of the lesson and engage students with the formation of a mini-landfill. Ask students to identify several materials to include in their landfill. I suggest that the teacher supply these materials for students. Landfill materials should consist of organic materials (e.g., food scraps which are likely to decompose quickly) and inorganic materials (plastics or metals which are not likely to decompose or change minimally in the landfill environment). The exploration suggested for this lesson engages students with an analysis of their mini-landfill and the rate of decomposition of materials within the mini-landfill. I suggest that students use clear, plastic cups to house their mini-landfill.

Learning Goals for 4th Grade students:

Through this lesson, students will:

1. Be introduced to the importance of soil and its components.
2. Be engaged in a long-term experiment on the process of decomposition by observing changes in different substances while buried in a “landfill.”
3. Draw conclusions on the decomposition of certain materials in their model “landfill” and propose ways to reduce the non-decomposed materials going to landfills within American cities.

Learning Objectives (4th Grade Students):

1. Following this lesson, students will be able to:
 - a. Identify and describe the components of soil.
 - b. Describe the breakdown of plant material into soil through decomposition
 - c. Propose ways to solve simple environmental problems (recycling, composting).

National Science Education Standards

Standard A:

Teachers of science plan an inquiry-based science program for their students. In doing this, teachers

- Select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students.

Standard B:

Teachers of science guide and facilitate learning. In doing this, teachers

- Orchestrate discourse among students about scientific ideas.



Lesson developed by: Clayton Coffman

Editor: Deanna Lankford, Ph.D.

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Standard D:

Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science. In doing this, teachers

- Structure the time available so that students are able to engage in extended investigations.
- Create a setting for student work that is flexible and supportive of science inquiry.

Standard E:

Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive.

- Nurture collaboration among students.
- Structure and facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse.

Missouri GLEs – 4th Grade:

Strand 5: Processes and Interactions of the Earth's Systems

1. Earth's systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures
 - A. The Earth's crust is composed of various materials, including: soil, minerals, and rocks, with characteristic properties
 - a. Identify and describe the components of soil (e.g., plant roots and debris, bacteria, fungi, worms, types of rock) and its properties (e.g., odor, color, resistance to erosion, texture, fertility, relative grain size, absorption rate).
2. Earth's systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes
 - A. The earth's materials and surface features are changed through a variety of external processes
 - a. Observe and describe the breakdown of plant and animal material into soil through decomposition processes (e.g., decay, rotting, compositing, digestion)
3. Human activity is dependent upon and affects Earth's resources and systems
 - A. The Earth's materials are limited natural resources affected by human activity
 - a. Identify the ways human affect erosion
 - b. Propose ways to solve simple environmental problems

Strand 7: Scientific inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking.
 - B. Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations
 - a. Make qualitative observations using the five senses
 - b. Determine the appropriate tools and techniques to collect data

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Potential Student Misconceptions:

Student misconceptions associated with the topic of soil formation and decomposition include:

- Materials which decompose simply disappear and no longer exist in any form.
- Soil is in a fixed quantity on Earth and new soil does not form.
- All materials will decompose over time.

Terms to Know:

- **Decomposition:** to break down organic matter physically and chemically by bacterial or fungal action.
- **Organic:** a class of chemical compounds that now includes all compounds of carbon including plants or animals.
- **Inorganic:** noting or pertaining to compounds that are not composed of carbon.
- **Soil:** A natural substance formed from particles of weathered rock (sand and gravel particles) and organic particles consisting of bits of leaves, stems, animal waste, as well as rotting plant and animal bodies.

Background Information for Teachers:

Prior to the start of the unit on “Changes in the Earth’s surface”, students should be provided an opportunity to construct their “mini-landfills.” The purpose is to provide the landfill objects an opportunity to demonstrate decomposition (or not). Mini-landfills should be constructed about 4 weeks prior to the unit. Provide materials for students to add to their mini-landfills.

Decomposition is the process in which organic materials (materials which are biological in origin such as food waste, cotton fabric, paper, or plant material etc.) are broken down into simpler components via environmental factors. The factors in the environment which control this decomposition are mostly biological: microorganisms in the soil actually digest these materials and release the broken down components as waste into the environment. These simpler components are then absorbed by plants or other organisms more easily. Decomposition is therefore a key process in the environment by which matter is recycled. The microorganisms which break down these components are several species of bacteria and fungi which are present in most soils. The presence of acids in the soil also contributes to decomposition.

These organisms themselves need other things to live. The decomposing material acts as a food source, but they still need water and appropriate temperatures to live. The fourth grade activity focuses on the ability of different substances to be broken down. The organic materials listed (leaves, cotton string, food waste, wood, and paper, etc.) can be consumed by these microorganisms, though not always equally. Students should observe that some of these materials are broken down a lot and some are broken down little. These differences are due to the actual chemical composition of these materials. For example the leaves, cotton string, and leaves are primarily composed of cellulose, a plant material which lots of organisms are capable of digesting. The wood though is primarily composed of lignin, which is a more difficult molecule to digest and fewer organisms are capable of using it as a food source. The non-organic materials (those materials which are not of biological origin) such as plastic and nylon string may break down very little or not at all. These materials are made from petroleum

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byproducts and since they are synthetic (made by humans), not many organisms exist which have the natural ability to break them down.

The fifth grade activity focuses on examining the effects of environmental factors on decomposition. Water is important for the survival of these decomposing microorganisms and so its presence is necessary for decomposition to occur. For example dry foods such as rice, flour, sugar, dried fruit, or nuts, will not decompose if they are kept dry as the bacteria and fungi do not have the necessary water to live. However they can be eaten by insects, which is not (strictly speaking) what we mean by decomposition in this context. The presence of microorganisms is also important for this process. If a sterile leaf was placed in sterile soil with sterile water, little decomposition would occur since no microorganisms are present. In the fifth grade activity sand is used as a semi-sterile soil substitute. Sand has little or no organic matter and so there is nothing for microorganisms for feed on (though they may be present at low levels). Sand also lacks natural acids which aid in the decomposition process.

Landfills are designed to maximize decomposition while minimizing the leakage of toxic chemicals into the environment. Layers of trash are alternated with layers of soils, and the entire structure is contained by a “geomembrane” which prevents leakage of chemicals and allows for (in some cases) combustible gasses (e.g. methane) produced by decomposition to be used for energy. To maximize decomposition the entire structure is kept moist and natural soil is added to make sure appropriate microorganisms are present.

Materials:

Bottom of water bottle (cut the top off of the bottle and remove label to create a beaker-like container enabling children to observe materials in the mini-landfill)

Backyard soil

“Landfill” material suggestions:

Newspaper, tree leaves, grass, plastic, wood, strings (nylon and cotton) etc.

Cookie sheet or newspaper for students to study landfill content

Engage:

Brainstorm with students:

- Ask students what happens to the trash at their house after the trash truck picks up the trash? (In most cases, students will not know the answer, but a student may know that trash goes to the “landfill,” or “dump”). Discuss that the purpose of a landfill is to store garbage (possibly indefinitely).
 - As a whole class, have the students brainstorm the types of materials that their household puts in the “trash.” Construct a list using butcher paper that can stay in view for this lesson.
 - Ask students - where else would we put trash from our homes?
- Ask students to share examples of their household recycles materials found in the trash. Make a list of trash materials and materials which can be recycled.
- Have students share why they recycle the materials that are on the list.
- Ask students if they understand the term “composting.”

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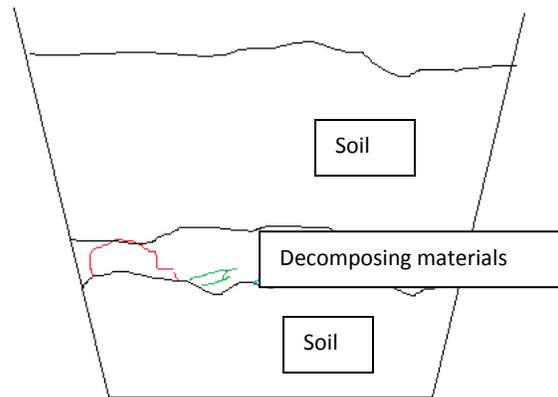
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- End the engage portion of the lesson by: Watching the video “How to teach kids about composting” www.youtube.com/watch?v=7HMDnsKgoB8
- Reflect upon the “mini-landfills” that students created prior to this lesson.
 - Ask students to share the types of materials that were placed in their landfills prior to this activity.

Explore (Completed prior to this lesson):

Constructing the “mini-landfills” (to be done prior to this lesson).

1. Soil for this activity can be collected from your backyard. If it is dry, you should wet it with water enough to dampen it but not turn it into mud.
2. Each student should be given a clear, plastic cup and a spoon.
Each student should be allowed to select 5 different materials to put in their mini-landfill.
 - *Note: some materials will completely “disappear” (decompose) in their landfills. Therefore, you may consider having the students tie string around the object prior to putting it in the landfill.
 - *Note: in order to facilitate decomposition in some materials, all the landfill materials should be cut into small and thin pieces in order to fit inside the cup and be covered with soil.
3. Students should measure the mass of each of their objects to the nearest gram.
4. Have students fill their landfill cups about ½ full with the soil.
5. Have students place their landfill materials in the cup.
6. Students should keep an accurate record of the materials which are added to their land fill, using the table provided.
7. Have students cover their landfill materials with soil. It is not necessary to have the soil all the way to the top of the cup.
8. It may be necessary to dampen the soil all the way through the soil column in the bottle – but do not create mud!
9. Have students monitor their landfills and keep the soil moist all the way to the bottom of the cup throughout this experiment (once a week).
10. Students should construct a table in their science journal similar to the one found below. They should record their initial observations of the object and list the objects they put in their landfill so that several weeks later they can recall what objects they should be looking for.



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- *Note: if you plan to use tree leaves, be sure to choose leaves that are thin and easily decomposable (maple leaves, hackberry leaves). Try not to use thick leaves as they will not decompose very fast (oak leaves).

For today's lesson:

- a. Have students collect their landfills, and with a section of newspaper have them carefully dissect their landfills.
- b. Students can slowly dump the soil and landfill contents of their cup onto the newspaper. Have the students observe the soil and landfill contents carefully as they dump the soil and landfill materials out of the cup and onto the newspaper.
- c. Instruct students to separate out the landfill materials as they find them.

| Landfill Object | Initial Mass grams | Decomposition | | Final Mass grams | Amount of Decomposition | | |
|-----------------|--------------------|---------------|----|------------------|-------------------------|----------|-----------|
| | | Yes | No | | A lot | A little | No change |
| | | | | | | | |
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***Note:** A complete table can be found at the end of the lesson. Students should record in their table the amount of decomposition of the objects from their landfill. The table provided allows for additional materials to be added to the landfill.

Explain:

- In groups of four (or other small groups) students will complete their table to include:
 - An indication of decomposition within the mini-landfill
 - Yes
 - No
 - The final mass of each substance or material placed in the landfill
 - Remind students to record their mass in grams
 - the relative rate of decomposition observed among the materials within the landfill
 - A lot
 - A little
 - No change
- Ask students to reflect upon the conditions of materials in their landfill and the initial masses of each material. Next ask students to:
 - Identify similarities among landfill materials in terms of initial and final masses
 - Were the rates of decomposition the same among the materials placed in the landfill?
 - Ask students to identify common characteristics of materials placed in the landfill

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- Are there common characteristics of materials which decomposed quickly in the landfill?
- Ask students if these materials would be likely to decompose within a city landfill or dump.
- Remind students to back up their claims with evidence gathered during the investigation.
- Each group should share their experiences with the landfill with the rest of the class.
- Suggestion:
 - Consider inviting the city engineer or a civil engineer working with the design landfills to speak to the students.
- Discuss the following points with the students:
 - Why did some materials decompose more rapidly than others?
 - Did the mass of soil change during the experiment? Did the amount of soil increase or decrease?
 - How is soil related to decomposition?
- Some cities offer recycling of materials including glass, aluminum, paper, and some plastics.
 - Ask students what happens to materials such as aluminum when aluminum soda cans are recycled.
- Emphasize that decomposed materials have not “disappeared.”
 - It is important to emphasize the “Conservation of Mass” in this lesson. The materials which decomposed did not disappear; they were broken down into the soil within the landfill. These substances have taken on a different form because of the decomposition.
 - Students should be familiar with the concept of conservation of mass (“Everything goes somewhere.”) and should leave the lesson understanding that bacteria, fungi, and other microorganisms break down the materials which decompose into smaller pieces, essentially taking the material apart, and these microscopic parts of the material actually become part of the soil. In fact, these tiny bits of organic matter become fertilizer for future plants which grow in the soil.

Extend/Elaborate:

- In order to reinforce decomposition, recycling, and composting, students should revisit the original brainstorming list of materials created at the beginning of this lesson.
 - Ask the students to separate materials into those likely to decompose and those which are unlikely to decompose within a landfill
- Arrange to take students to the media center
 - Design a media quest by identifying a series of websites which will provide appropriate information on:
 - The make-up and formation of soils
 - Decomposition of organic materials
 - Leaves, food scraps, grass clippings, etc.

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- During a whole-class discussion ask students to share their knowledge of decomposition and soil formation.
- Assignments integrating language arts and science
 - Ask students to write a letter to the city engineer to identify materials which could be recycled and not added to the landfill
 - In the letter:
 - Ask students to support claims about materials which can be recycled and converted into new products such as aluminum cans, plastic bottles, paper, etc.
 - Ask students to explain why recyclable materials should be kept out of the landfills
 - Remind students to draw upon evidence gathered from experiment to support claims about the landfill

A diagram of a typical landfill is provided at the end of this lesson plan (http://www.wm.com/about/community/pdfs/Anatomy_of_a_Landfill.pdf).

Additional Materials – Books for Students:

Where Does the Garbage Go?: Revised Edition

http://www.amazon.com/gp/product/0064451143/ref=pd_lpo_k2_dp_sr_1?pf_rd_p=486539851&pf_rd_s=po-top-stripe-1&pf_rd_t=201&pf_rd_i=0471254991&pf_rd_m=ATVPDKIKX0DER&pf_rd_r=1R38NPPDHXCBRVJQPP7B

Recycle!: A Handbook for Kids

http://www.amazon.com/gp/product/0316309435/ref=pd_lpo_k2_dp_sr_3?pf_rd_p=486539851&pf_rd_s=po-top-stripe-1&pf_rd_t=201&pf_rd_i=0471254991&pf_rd_m=ATVPDKIKX0DER&pf_rd_r=1R38NPPDHXCBRVJQPP7B

The Magic School Bus Meets The Rot Squad: A Book About Decomposition

http://www.amazon.com/Magic-School-Meets-Squad-Decomposition/dp/0590400231/ref=sr_1_2?s=books&ie=UTF8&qid=1320438570&sr=1-2

Additional Materials – Books for Adults/Teachers:

The Waste Crisis: Landfills, Incinerators, and the Search for a Sustainable Future

<http://www.amazon.com/Waste-Crisis-Landfills-Incinerators-Sustainable/dp/0195128982>

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Garbage Land: On the Secret Trail of Trash

http://www.amazon.com/Garbage-Land-Secret-Trail-Trash/dp/B001G60FWA/ref=pd_bxgy_b_img_b

Gone Tomorrow: The Hidden Life of Garbage

http://www.amazon.com/Gone-Tomorrow-Hidden-Life-Garbage/dp/1595581200/ref=pd_bxgy_b_img_c

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Typical Anatomy of a Landfill

Protective Cover

- 1 COVER VEGETATION**
As portions of the landfill are completed, native grasses and shrubs are planted and the areas are maintained as open spaces. The vegetation is visually pleasing and prevents erosion of the underlying soils.
- 2 Top Soil**
Helps to support and maintain the growth of vegetation by retaining moisture and providing nutrients.
- 3 PROTECTIVE COVER SOIL**
Protects the landfill cap system and provides additional moisture retention to help support the cover vegetation.

Composite Cap System

- 4 Drainage Layer**
A layer of sand or gravel or a thick plastic mesh called a geonet drains excess precipitation from the protective cover soil to enhance stability and help prevent infiltration of water through the landfill cap system. A geotextile fabric, similar in appearance to felt, may be located on top of the drainage layer to provide separation of solid particles from liquid. This prevents clogging of the drainage layer.
- 5 Geomembrane**
A thick plastic layer forms a cap that prevents excess precipitation from entering the landfill and forming leachate. This layer also helps to prevent the escape of landfill gas, thereby reducing odors.
- 6 Compacted Clay**
Is placed over the waste to form a cap when the landfill reaches the permitted height. This layer prevents excess precipitation from entering the landfill and forming leachate and helps to prevent the escape of landfill gas, thereby reducing odors.

Working Landfill

- 7 Daily Cover**
At the end of each working period, waste is covered with six to twelve inches of soil or other approved material. Daily cover reduces odors, keeps litter from scattering and helps deter scavengers.
- 8 Waste**
As waste arrives, it is compacted in layers within a small area to reduce the volume consumed within the landfill. This practice also helps to reduce odors, keeps litter from scattering and deters scavengers.

Please Note: This illustration depicts a cross section of the standard environmental protection technologies of modern landfills. While the technologies used in most landfills are similar, the exact sequence and type of materials may differ from site to site depending on design, location, climate and underlying geology.



(Not to scale)

Leachate Collection System

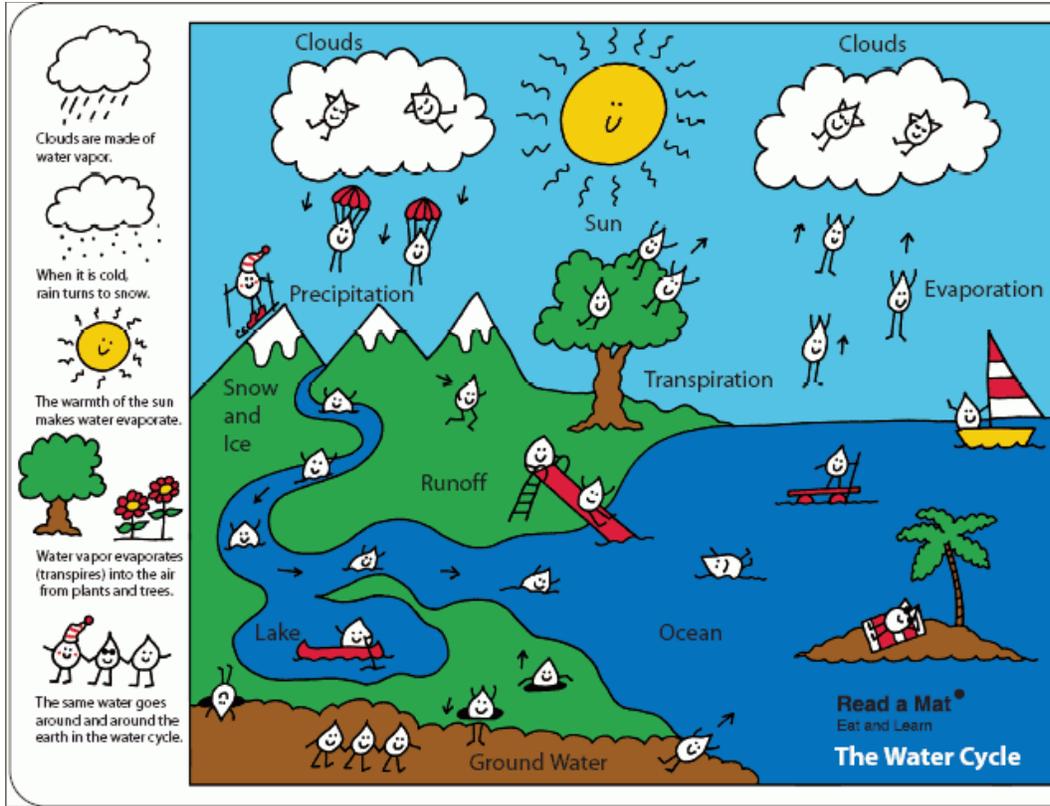
Leachate is a liquid that has filtered through the landfill. It consists primarily of precipitation with a small amount coming from the natural decomposition of the waste. The leachate collection system collects the leachate so that it can be removed from the landfill and properly treated or disposed of. The leachate collection system has the following components:

- 9 Leachate Collection Layer**
A layer of sand or gravel or a thick plastic mesh called a geonet collects leachate and allows it to drain by gravity to the leachate collection pipe system.
- 10 Filter Geotextile**
A geotextile fabric, similar in appearance to felt, may be located on top of the leachate collection pipe system to provide separation of solid particles from liquid. This prevents clogging of the pipe system.
- 11 Leachate Collection Pipe System**
Perforated pipes, surrounded by a bed of gravel, transport collected leachate to specially designed low points called sumps. Pumps, located within the sumps, automatically remove the leachate from the landfill and transport it to the leachate management facilities for treatment or another proper method of disposal.

Composite Liner System

- 12 Geomembrane**
A thick plastic layer forms a liner that prevents leachate from leaving the landfill and entering the environment. This geomembrane is typically constructed of a special type of plastic called high-density polyethylene or HDPE. HDPE is tough, impermeable and extremely resistant to attack by the compounds that might be in the leachate. This layer also helps to prevent the escape of landfill gas.
- 13 Compacted Clay**
Is located directly below the geomembrane and forms an additional barrier to prevent leachate from leaving the landfill and entering the environment. This layer also helps to prevent the escape of landfill gas.
- 14 Prepared Subgrade**
The native soils beneath the landfill are prepared as needed prior to beginning landfill construction.

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<http://ga.water.usgs.gov/edu/watercycleplacemat.html>

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The Water Cycle Under Your Feet

Jim's father wanted to build a compost pile for his garden. Jim was learning about decomposition and the importance of the water cycle in decomposition in his 5th grade class. Jim's father wanted to build his compost pile by burying grass clippings with sand. Jim's father thought that the sand would allow water to flow to the grass clippings more quickly and help to decompose his grass clippings faster. Jim told his father that soil may be a better thing to use as it holds onto the water longer and would help decompose the grass clippings faster.

What do you think? Should Jim's father use sand or soil to help decompose his grass clippings? Explain why you chose the sand or soil to use.

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| | | | | | | | |

