Learn About Decomposition by Creating Compost

Brief Description:

Students, working in groups, will create a small composter, monitor and record the decomposition process, and reflect on the final product of decomposition in their composter.

Objectives:

Students will:

1. Understand what compost is and how it compares to nature.
2. Create compost bottles in order to record, measure, observe and evaluate the decomposition process of plants, vegetables and fruit.

Time:

Initial set up for the compost bottle lab takes one class, and the monitoring of the compost bottles should be done during each class over three to four weeks allowing 15 to 20 minutes for measurements and observations each class period. The final compost analysis/evaluation will take one class.

Preparation:

1. A lesson on soil health, components and organic versus inorganic materials is suggested. Suggested lessons are *Gardening for Grades*: It all Begins with Soil and Nutrients for Life Foundation's Properties of Soil and/or Plant-Soil Interaction.

2. This tactile/inquiry lab on composting/decomposition requires that the teacher collect enough plant and vegetable scraps to fill at least 30 two-liter bottles.
3. A five-gallon bucket with a lid is recommended for collecting plant and vegetable scraps. Depending on the size of the school, enough fruit and vegetables can be collected through three to four lunch shifts. Be careful NOT to collect meat or dairy products in the bottle, such as ranch dressing or hot dogs and hamburgers.

Materials:

- Two-liter plastic bottles
- Scissors
- Masking tape
- Permanent marker
- Balances for measuring mass
- Metric rulers
- Beakers that measure in milliliters (mL)
- Plant and vegetable wastes, such as leaves, stems, tomatoes, banana peels, orange peels and apple cores
- Red wiggler worms (earthworms)
- Soil
- Water
- Tongs for placing plant and vegetable waste in the two-liter bottles

Vocabulary:

compost, compostable, decomposition, decomposer, micro-organism, organic, inorganic, bacteria, fungi, aerobic, anaerobic, humus, nutrient, symbiosis, symbiotic, mutual, quantitative, qualitative, biodegradable, non-biodegradable, prediction, evaluate, matter, elements, biotic, abiotic, biogeochemical cycle and Law of Conservation of Matter

Background:

Composting, often described as nature's way of recycling, is the biological process of breaking up of **organic** waste such as food waste, leaves, grass trimmings, paper, worms and coffee grounds into an extremely useful humus-like substance by various **micro-organisms** (including **bacteria** and **fungi**) in the pres-

Florida Standards:

SC.6.N.1.5, SC.6.N.1.3, SC.7.N.1.5, SC.7.L.17.2, SC.7.L.17.3, SC.8.N.1.5, LAFS.6.SL.1.2, LAFS.6.SL.1.3, LAFS.6.SL.2.4, LAFS.68.RST.1.1, LAFS.68.RST.1.2, LAFS.68.WHST.2.6, LAFS.68.WHST.3.7, MAFS.7.SP.2.4, VA.68.C.2.1, VA.68.C.2.2, VA.68.C.2.3, SS.7.C.2.12, SS.7.C.2.13, and SS.7.C.2.14

ence of oxygen. **Humus** refers to natural decay or decomposition. **Compost** is created when organic materials such as leaves, grass, eggs, coffee grounds, and fruit and vegetable peelings are mixed with soil, water and **decomposers** such as fungi, bacteria and earth worms. The decomposers consume the organic material and reduce it to simple **nutrients**, such as nitrogen, phosphorus and potassium that can once again be used by plants for growth and health. Compost is an excellent fertilizer because the nutrients that comprised the leaves, grass, eggs, and fruit and vegetable peelings are returned to the soil.

Compost energizes the soil food web, which is made up of microscopic bacteria and fungi, along with earthworms, crickets, and many other life forms. Many fungi in compost form **symbiotic**, or **mutually** rewarding, partnerships with plant roots, making it possible for vegetables to feed themselves more efficiently. Research shows (Ohio University) that compost enhances the ability of tomatoes and other vegetables to stand up to common diseases and may also improve their flavor and nutrition. Compost also helps the soil retain moisture. Through composting you enhance your garden's ability to grow healthy plants while reducing your volume of trash.

A compost bin is an efficient way of making rich compost and results in the use of fewer yard-trash and garbage bags. A compost bin allows for control of the four factors that affect the speed of decay: oxygen, water, food and temperature. By managing these factors, the naturally slow process of decay can progress much faster. To work well, the compost container needs to be moist, and should be stirred in order to better promote air circulation and fresh oxygen.

Carbon-rich material is known as "brown" matter. Nitrogen-rich material is known as "green" matter. There needs to be a good balance of these two materials to form good quality compost. Too much of either one will result in poor compost. A healthy compost contains a balance of one-quarter green stuff such as vegetable scraps, coffee grounds, or grass clippings —to three-quarters brown stuff such as leaves, straw, grass clippings, shredded paper, coir fiber, wood pellets, or sawdust. In other words, ¼ green matter to ¾ brown matter.

Compost ingredients are broken down by microorganisms, which require aerobic conditions (the presence of oxygen) to thrive. Frequent turning of the compost pile provides this necessary oxygen. Meat and dairy products, such as cheese, yogurt, milk and some salad dressings, however, attract microorganisms requiring **anaerobic** (the absence of oxygen) conditions for decomposition. When meat and dairy products are put in a compost pile, the aforementioned anaerobic microorganisms generate foul-smelling byproducts. This, in turn, attracts flies and their maggots, vermin, (such as cockroaches, mice, rats, raccoons, opossums and skunks) and neighborhood dogs and cats. It also slows down the composting process. Thus, it is highly recommended to keep compost bins and containers free of meat (chicken, pork, deli-meats, hot dogs and hamburgers) and dairy products.

Composting is an excellent vehicle to witness the **biogeochemical cycle** and the **Law of Conservation of Matter**. In terms of composting, the biogeochemical cycle is the process where materials are cycled through living organisms and returned back to the earth or soil. The Law of Conservation of Matter states that matter cannot be created nor destroyed. Matter elements can only change form.

*There are food safety concerns when using compost in schools. Compost must be created correctly. Please see "Tips from the Experts: Rules for Safe Compost" on page 47 of *Grow to Learn School Gardening Guide*. Additional advice and published materials can be found at your local UF/IFAS County Extension Office.

Introduction:

1. Begin class with a "starter" or "warm-up" question such as: "In the NE Florida woods, a banana peel will decompose in one month, an apple two months, a leaf five months, and a cigarette butt will take two years. What is the average time, in **months** that the above products will decompose?" **Answer:** 32 months/4 products = 8 months per product.
2. Allow students time to answer starter question and discuss the process of decomposition. Next, discuss how nature naturally recycles products through the process of decomposition. Ask students to name decomposers and/or scavengers from their environment such as vultures, crabs, worms, maggots, fungi and bacteria.
3. Discuss with students that soil takes a very long time to be created naturally. Inorganic material is slowly created by the parent material breaking down and moving to the surface. Organic material is slowly created by once living items dying and decomposing. Both of these processes take time and therefore we need to often fabricate these soils.
4. Read aloud, the "Background" on compost and decomposition. Possible discussion questions:
   "What is the difference between organic and inorganic material?"
   "What benefits do the different materials have for plants?"
   "What organisms aide in the decomposition of waste?"

"How does compost benefit plants?"
"What is the difference between "aerobic" and "anaerobic?"
"Why is it NOT recommended to put meat and dairy products in compost?"

5. Next, place students in groups of four, and pass out the materials for creating a compost bottle: two-liter bottle, scissors (you may want to pre-cut the bottle), masking tape, permanent marker, 500 mL beaker, water, soil, metric ruler and balance for measuring mass in grams.

Activity 1:

1. Have students remove label and cut at the top of the bottle where the bottle widens. Instruct students to leave about one inch of plastic and do not cut the entire top off. (Again, you may want to pre-cut and remove labels before class.)
2. Have students put the bottle cap in the recycle bin and then place masking tape across the top instead of a bottle cap and poke three to four holes with a pen in the masking tape.
3. Fill the bottle with 500 mL of soil (can be dirt from outside the classroom) and then pour 20 mL of water on top of the soil in the bottle.
4. Using tongs, add the plant and vegetable compost to the bottle, filling to the top of cut area of bottle.
5. Now place one or two earthworms in the bottle.
6. Have students reattach the top part of the bottle to the main body of the bottle using masking tape.
7. Have students write their names on the masking tape where they reattached the bottle.
8. Pass out *Compost Evaluation Worksheet*, have students complete question one and collect the papers. At the end of the forth week pass, the worksheet back out and have students complete the rest of the questions.
9. Now pass out the *Compost Bottle Monitoring Chart* to each student and have students write their names at the top of paper. Remind students that they will be responsible for monitoring and recording their measurements and observations for three to four weeks on their own paper.
10. Have students measure the mass and height of the bottle and record their measurements, along with day's date, on their *Compost Bottle Monitoring Chart*.
11. Students need to describe the appearance of their compost pile under the "Qualitative Observations/Description of Contents" column on the chart.
12. Finally, students are to predict which product they believe will decompose fastest and which the slowest and explain why they choose those products in the Evaluation Questions #1.
13. Students are to place their bottle in the same location in the classroom each day as they leave the class. **If possible**, have some groups place their bottle in area that receives sunlight in the classroom and other groups in shadier or dark areas of the classroom. (Also, maybe add one Cheetos, cheese puff, or Frito to each bottle.)
14. For the next three to four weeks, students should measure the mass and height of the compost pile, and write down their qualitative observations.
15. Students should **GENTLY** stir the contents of the bottle **AFTER** measuring the bottle each class in order to allow more oxygen to flow through the compost pile.

Extensions:

1. Allow students to compost different items to determine if some items create a more nutrient-rich compost.
2. In compost, high temperatures are essential for destruction of pathogenic organisms and undesirable weed seeds. Have students check temperatures of the compost pile using a compost thermometer throughout the school year to make sure it is maintaining safe temperatures. Have students keep a journal that is accessible by all students to keep accurate data of the class compost pile. For more information on compost temperature students can visit http://whatcom.wsu.edu/ag/compost/fundamentals/needs_temperature.htm.
3. Students can take samples throughout the composting process to check for bacterial levels.
4. Students should now understand that many things have to be thought about for optimal plant growth. Students will need to take soil samples in the current school garden to determine nutrient content. Next students need to complete soil moisture activity to determine the moisture content in the school garden. Students will choose which plants they would like to plant in the garden and research soil requirements and engineer soil for their garden. They need to think about water holding capabilites, permeability, soil structure and nutrient content. Once designed they will need to devise experiments to test the effectiveness.

Evaluation:

1. Assess student performance in completing the assigned lab measurements.
2. Grade *Compost Evaluation Worksheet* for accuracy.

Compost Bottle Monitoring Chart

Name _____

Date _____ Per._____

Directions: After creating your compost bottle, record the date, measure the mass and height, and describe the contents of the bottle. Repeat these steps for each class until the contents in the bottle have turned to compost.

	Quantitative Observations		Qualitative Observations
Day/Date	Mass in grams (g)	Height in centimeters (cm)	Description of contents
Day __1__ Date ____			
Day ____ Date ____			
Day ____ Date ____			
Day ____ Date ____			
Day ____ Date ____			
Day ____ Date ____			
Day ____ Date ____			
Day ____ Date ____			

Compost Evaluation Worksheet

1. **Predict** which product in your bottle you believe will decompose the fastest and which product will decompose the slowest. Explain in detail why you chose each product.

2. Was your prediction as to which product would decompose the fastest and slowest supported? Explain.

3. Did the mass of your bottle change over time? Explain why you believe it changed or why it did not change?

4. Did the height of your compost pile change? Explain why it changed or why it did not.

5. Did the items decompose at the same rate? Explain why they did or did not decompose at the same rate.

6. What was the role of the earthworm in your bottle? Explain in detail.

7. What other organisms would have aided in the decomposing of the materials in your bottle?

8. What items do you consume at home **and** at school that are compostable?

9. How does the compost bottle model the **biogeochemical** cycle? Explain in detail.

10. How does the compost bottle model the **Law of the Conservation of Matter**? Explain in detail.

11. Observe a group whose bottle was in a dramatically different location than yours. Did it decompose at different rate? Why or why not?

Compost/Decomposition

Sample Pre-Post Test Assessment

Directions: Answer each question to the best of your ability.

1. Name two organisms that aid in the decomposition of plant matter.

2. Name three products found in and around your home that would be suitable for composting.

3. How is mixing compost into garden soil beneficial to plants growing in the garden?

4. What factors affect how fast or slow compost decomposes?

5. How is composting a demonstration of the biogeochemical cycle?