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Keeping it Green: Using a Compost to Improve Student Learning

Spencer Mesick
Clinton High School

Kayla Hendrix
Lewis Central Middle School, Council Bluffs

Keeping it Green

Photo by Alicia Jo McMahan
Graphic Work by Joe Taylor

USING A COMPOST TO IMPROVE STUDENT LEARNING

Spencer Mesick, Clinton High School
Kayla Hendrix, Lewis Central Middle School, Council Bluffs

ABSTRACT: This article discusses ways in which composting might be used to mentally engage students with science content. Incorporating a compost pile in the classroom provides ample connections to future science content (e.g., conditions necessary for the life of organisms in a well running aerobic compost, what decomposition means in a biological sense, aerobic vs. anaerobic decomposition, food webs, respiration, recycling of nutrients, landfill issues, etc). Also, reflecting the complexities of effective science teaching, the article makes clear the crucial role of the teacher during the activity. The science content and activity addressed in this article are appropriate for 9th - 12th grade biology or general science students. The lesson could easily be modified for 6th – 8th life science students by making appropriate decisions regarding what science content to forego. *This article promotes National Science Education Content Standards A, C, F and G, and Iowa Teaching Standards 1, 2, 3, 4, 5, and 6.*

Efforts to increase awareness of and take care of natural environments have a long history. Recent efforts at "going green" are encouraging because they come not only from the expected environmental organizations, but also from governments and businesses. The activities described in this article are directed at helping students understand several important biological concepts as well as ways they can "go green." Moreover, the article discusses more generally how science education might be improved through research-based decision-making.

Before discussing composting, we want students to make observations related to decomposition. We want students to think about what happens to living tissue after it dies and begins to decompose. If we compared living organisms to compost, students might struggle to see how the two are connected. Rather than simply discussing with students the process of decomposition, we want them to make observations that will help them think deeply about the process.

One month prior to the activity, obtain gallon size freezer bags and food such as apples and bananas. Cut the food into smaller pieces and for each group of two students, place some food in one freezer bag and let it sit for a month at room temperature. One day before the activity, place fresh foods of the same types, cut to approximately the same sizes, in another freezer bag.

Day 1 - Initial Observations

Begin the activity by forming groups of two students. If you have an odd number of students in your class, have the one student lacking a partner conduct the same work, but teamed with another group of two students. We avoid groups of three to prevent the off-task behavior that often occurs when the task only requires one or two students.

We have each group of students carefully observe the food in the two bags and take notes of what they see. The specific observations students make will depend on what food was placed in the bags. Common observations include:

- looks like food
- in one bag the food turned brown
- looks like both bags contained the same food but they look different
- the brown food is squishy
- the brown food smells bad

To further students' observations and thinking, we ask questions such as,

- "What might account for the differences between the food in the two bags?"
- "What happens to food as it gets older?"

To lead to the concept of microorganisms we ask questions similar to,

- "Why isn't old food good for you?"
- "Why might you get sick if you eat old food?"

These questions are vital to bring forth any misconceptions that students might have. For example, students often think that food shrivels up as it ages or old food is simply eaten by organisms such as ants.

To push students a bit further and prepare them for our next activity with compost we ask,

- "What might the 'brown food' look like in another six months?"

Now that students have begun contemplating the decomposition of food, they are ready to begin observing and making connections to compost.

Introducing Compost

We now draw students' attention by holding up a scoop of compost and asking,

- "What things do you notice about this material?"

Students often note the material looks like dirt, has stringy material, and may even claim the material is what the fruit will turn into. Even if students don't make this last claim, we ask,

- "How could you learn more about this material or gain evidence for your ideas?"

Students quickly note that they need to make more detailed and up-close observations.

Before sending students off to get some compost we ask,

- "How much compost do you need to make adequate observations?"

We fill up the scoop then slowly dump out the compost and ask students to let the teacher know when to stop. Approximately one cup of compost is all students need. While students could simply be told to take one level cup of compost, we instead choose to make students *think* about this decision. This reflects our ubiquitous strategy of engaging students in thinking about what they are doing in all aspects of this activity and our course.

Importantly, we have two or three buckets from which students can get compost. Having multiple locations prevents students from lining up in one location and reduces classroom management issues.

Next, students write observations about the compost on their personal white boards or notebooks. We prefer the whiteboards so that we can better see what students are noting as we walk around the room and the whiteboards are great for having students share their work with the class. When a group appears to be finished we ask students in the groups to explain some of their observations. We encourage students to make more detailed observations and deepen their thinking by asking questions such as:

- "What do you mean by _____?"
- "How could you be more clear?"
- "You've noticed _____. Why do you think this is so?"

When all groups have written at least three or four observations on their whiteboards, we hold a whole-class brainstorming session. When writing students' observations on the board, we use their exact words to convey to the class that their ideas have value. To draw out multiple answers we use appropriate wait-time I (3-5 seconds after asking a question) and wait-time II (5-7 seconds provided after a student has spoken) before asking additional questions.

Moving Towards the Microscopic

Once students have made some macroscopic observations of the compost, we want them to make microscopic observations. Sometimes students will suggest using microscopes, but most years we have to suggest using the microscopes. This is often the first time we use the microscopes in our classes so we review how to use the microscopes and how to prepare wet mounts.

To push students in the direction of making microscopic observations we ask,

- "If the fruit is being turned into this soil-like substance, what might be causing this?"
- "How could we look more closely at the compost or the brown fruit to investigate the cause?"

Once students suggest using the microscopes, we explain that we must first mix the materials with water to make our observations with the microscopes possible. This usually concludes day one of the activity and students will use the microscopes starting day two.

Day 2 - Under the Microscope

We prepare for day two by mixing water with (or running water through) some compost and some water with the brown fruit. On day two, we show students how to prepare wet mounts from the two samples. As they investigate their samples, students start to find various microorganism and we ask,

- "What importance can you place with these microorganisms?"

We challenge students to consider alternative explanations by asking,

- "How can you know these organisms came from the compost or the fruit?"

Students usually wonder if the microorganisms might be in the water. They quickly note they could observe "clean" water and investigate this possibility by preparing slides with just water.

The purpose of these introductory activities is to scaffold to the notion that microorganisms are living in the compost and are somehow connected to decomposition. Unless students understand these ideas, they will not be able to fully understand the other content that we will link compost to throughout the year. Some of this content might include the food web existing in the compost and how all living organisms (even organisms that can't be seen with the naked eye) must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.

Importantly, these activities are not simple prescriptions for student engagement. As we help our students learn new content during any activity we are proactively thinking about potential extension activities, possible student struggles, how we will help students make sense of the activities while keeping them mentally engaged, and (perhaps easiest to forget) how we will manage the classroom. More specifically, these key decisions include: the materials to incorporate, how to hand out materials, the safety of the students, how the lesson will be assessed (formative and summative), and key questions to ask along with potential student responses.

Day 3: Developing Conceptual Understanding

Day three is dedicated to developing and applying what students have learned. Once students understand that living microorganisms exist on the decomposing food and within the soil and play a part in the decomposition process, we label these living things as decomposers. Depending upon when you use these activities, connections and comparisons might also be made among decomposers, producers and consumers. We focus on similarities and differences such as: the type of organisms found in each group, where organisms are found, what the organisms use for energy, and what feeds upon the organisms. Some questions we might ask to help students develop a conceptual framework around decomposers include:

- "Why are the organisms we found in the compost so important?"
- "How do these organisms compare to other organisms with which you're familiar?"
- "How would our ecosystems be different without these organisms?"
- "How do these organisms contribute to cyclical processes?"

Importantly, our concept development is only just beginning. We revisit the compost pile and the concepts addressed here throughout the year. Later we will explain more about how the concept of composts can be used as a concept connecter throughout the school year.

Application: Compost in the Classroom

Before building the compost pile in the classroom, we want to ensure students understand the decomposition process. Specifically, we want students to consider what the microorganisms need to survive, what happens to the microorganism's waste, and what compost needs to thrive and decompose organic material.

We begin this discussion by asking,

- "What things do the decomposers need to survive?"

Students quickly note things like: water, food, space, and air. We then ask,

"How could we design a space for these organisms to live in the classroom?"

Students provide several useable ideas such as a garbage can and bringing in organic waste from lunch and adding water to the mixture, but usually fail to consider the oxygen needs. Considering the oxygen needs is vitally important to prevent the compost pile from becoming anaerobic and producing noxious fumes. To help students consider the oxygen, we ask them to revisit their list of what the organisms need to survive and ask,

- "Which items might we need to consider more carefully?"

If students still don't note how air getting to the compost might be problematic we ask,

- "Some of these organisms will live in the middle or bottom of the compost pile, what might be problematic for their survival?"

Student usually note that water and air might not get to them so we ask how we can ensure that these vital materials reach all parts of the compost pile. Students are usually concerned about having to "stir" the compost by hand, but after we note the pitchfork in the corner of the room, they are less concerned.

For our compost piles, we use large garbage cans with dime-sized holes cut throughout. We place a large plastic tray

(typically used for washing machines) under the garbage can to catch any drips or debris from the pile. Lastly, we use a pitchfork to turn the compost. Rather than creating more work for ourselves, we assign students to care for the compost pile: adding water, organic material, and turning the compost.

Linking Compost to Future Content

Including a composting pile in the classroom provides many opportunities to connect to various content standards. A compost pile can be used to scaffold to content such as the food web or energy flow (what feeds on what, and where the energy goes in compost) and natural selection and evolution (what happens if meat were added to the compost, if animals infected the compost with some disease, or how this might affect the microorganism population). Other content that compost can be used to scaffold to include human impact (what might humans add to the compost that wouldn't decompose, why would it not decompose, and how is this related to our landfills) or the knowledge of a cell (what makes up a decomposer or microorganism, how does this compare to the cells found in our body or in any other living consumer/producer.)

Getting at Student Ideas

The activities above rely heavily on student responses and generating student discussion. To encourage multiple student responses and participation in class, we are sure to use encouraging non-verbal behaviors (e.g. smile, make eye contact with students around the room, lean forward) that clearly portray that students' ideas are valued (Bavelas, et. al., 1995; Clough, et. al., 2008). Using questions that are a thought-provoking short-answer question or an extended-answer question throughout the student-teacher discussion are most valuable because they draw out student responses. Effective questioning encourages students to think through their answers (Penick, et. al., 1996). When students respond with an answer to our questions, we typically write the ideas on the board using the exact words that the student used.

Using the students' exact words will further promote an environment where the students consistently feel that the teacher values their ideas. As other students provide answers, these answers should also be written on the board using the exact words the student used. To draw out multiple answers we use appropriate wait-time in between responses and before asking any further questions. When using wait time in the classroom students will speak more often, provide more detail in their answers, and more thoroughly explain their responses (Rowe, 1986).

COMPOST SAFETY

Safety guidelines are important when a compost pile is brought into the classroom. At any point, when working with compost, do not permit the students to taste the materials. Including meats and dairy products in your compost pile may bring about safety hazards in the classroom such as unwanted parasites and smell.

Concluding Remarks

This activity does not go into great detail about how to make a compost pile in the classroom. Instead, we have tried to focus on how we mentally engage students in developing conceptual understanding about composting and decomposition. Instructions for making a compost pile have been compiled by experts in the U.S. Environmental Protection Agency, and can be found at the following website:

http://www.epa.gov/wastes/conserve/rrr/composting/by_compost.htm

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Spencer Mesick teaches 9th Grade Sciences at Clinton High School. He is a recipient of the Charles D. Drewes Memorial Award and is a member of NSTA and the Iowa Academy of Science. Contact Spencer at S.W.Mesick@gmail.com. Kayla Hendrix is a 7th Grade teacher at Lewis Central Middle School in Council Bluffs. She is a member of NSTA and the Iowa Academy of Sciences. Contact Kayla at khendrix16@yahoo.com.