Soil from Spoiled: Engineering a Compost Habitat for Red Wigglers

Subject Area(s) Life Science, Nature of Science

Associated Unit None

Associated Lesson None

Activity Title Soil from Spoiled: Engineering a Compost Habitat for Red Wigglers

Image 1

Image file: Learning to make compost

ADA Description: Image of a girl standing near a garden bed with compost in it. The girl is using her sense of touch to feel the soil made from composting.

Source/Rights: ©
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Caption: Feeling soil made from composting!

Grade Level 1 (K-2)

Time Required 60 minutes/day for 15 days

Group Size 3-5

Expendable Cost Per Group Approximately U.S. $30

Summary
Students will design the optimal environment for Red Wiggler worms in a compost bin. Students will learn about living and nonliving things, the habitat and life cycle of Red Wigglers, how Red Wigglers help convert organic waste into soil, as well as composting in nature and as a sustainable practice.

Engineering Connection

Environmental engineers are tasked with innovating ways to combat environmental issues with sustainable, practical solutions. Environmental engineers work towards reducing waste and pollution, protecting and maintaining clean air, water, and soil, as well as finding methods to combat the effects of natural or human activities. Composting, which is the natural process in which organic waste decomposes into rich fertilizer, offers a sustainable solution for many of these concerns that can easily be done in local communities and schools.

Engineering Category = 2
Choose the category that best describes this activity's amount/depth of engineering content:
1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords: Living, Nonliving, Compost, Organic waste, Red Wiggler Worm Vermicomposting, Castings, Decomposition, Habitat, Life cycle, Soil, Sustainability, Pollution, Habitat

Educational Standards
State STEM Standards

Florida State Standards:

SC.1.L.14.3 Differentiate between living and nonliving things.
SC.1.L.14.1 Make observations of living things and their environment using the five senses.
SC.1.E.6.1 Recognize that water, rocks, soil, and living organisms are found on Earth's surface.
SC.1.L.17.1 Through observation, recognize that all plants and animals, including humans, need the basic necessities of air, water, food, and space.
SC.2.E.6.2 Describe how small pieces of rock and dead plant and animal parts can be the basis of soil and explain the process by which soil is formed.
SC.1.N.1.1 Raise questions about the natural world, investigate them in teams through free exploration, and generate appropriate explanations based on those explorations.
SC.1.N.1.2 Using the five senses as tools, make careful observations, describe objects in terms of number, shape, texture, size, weight, color, and motion, and compare their observations with others.
SC.1.N.1.3 Keep records as appropriate - such as pictorial and written records - of investigations conducted.

LAFS.1.SL.1.1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups.
a. Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion).
b. Build on others' talk in conversations by responding to the comments of others through multiple exchanges.
c. Ask questions to clear up any confusion about the topics and texts under discussion.

LAFS.1.SL.2.5 Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.
LAFS.1.W.2.5 With guidance and support from adults, focus on a topic, respond to questions and suggestions from peers, and add details to strengthen writing as needed.
LAFS.1.W.3.7 Participate in shared research and writing projects.

ITEEA Standards

8. Students will develop an understanding of the attributes of design.
In order to realize the attributes of design, students should learn that:
A. Everyone can design solutions to a problem.
B. Design is a creative process.

9. Students will develop an understanding of engineering design.
In order to comprehend engineering design, students should learn that:
A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem-solving.
In order to comprehend other problem-solving approaches, students should learn that:
A. Asking questions and making observations helps a person to figure out how things work
B. All products and systems are subject to failure. Many products and systems, however, can be fixed

NGSS Standards

K-LS1-1 Use observations to describe patterns of what plants and animals (including humans) need to survive.
1-LS3-1 Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.
K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Prerequisite Knowledge
There is no requisite knowledge of this activity.

Learning Objectives
After this activity, students should be able to:
- Identify and differentiate between living and nonliving things.
- Make observations of living things, their environment, and how changes can impact their habitat.
- Identify the basic needs of living things (air, water, food, and space).
- Observe and describe the stages in the life cycle of Red Wigglers.
- Understand how soil is formed and that living and nonliving things are used as the basis of soil (such as rocks, dead plants and animals, as well as waste from animals, such as castings).

- Understand that compost is found in nature and is also a sustainable practice used to reduce food waste.
- Understand the steps of the engineering design process and its purpose.

Materials List

Each group needs:

- Four 12-Quart Clear Containers (compost bins)
- Various soil, leaves, and natural materials found in an outside environment for designing compost bins
    - If school environment has limited access to natural materials, teachers can purchase various items and students can choose which to include as their design challenge (for instance: dirt, topsoil, sand, mulch, rocks, leaves, and peat moss)
- Cardboard, newspaper, paper, and hay/pine needles to use as bedding for compost bin (see Troubleshooting Tips)
- Plastic cups - used to scoop natural materials from outside
    - Can replace with a sustainable option, such as reusable cups
- Large plastic bags (1-gallon) - used to add natural materials in before weighing
    - Can replace with a sustainable option, such as plastic or glass containers
- Organic waste - separate the same amount of organic waste (1 pound) in bags for each group
- Magnifying glasses
- 250 Count Red Wigglers - around 50 worms for each compost bin https://www.amazon.com/Uncle-Jims-Worm-Farm-Composting/dp/B00EZPSSGY

To share with the entire class:

- Electric drill to make air holes in compost bins
    - An alternative is to use a heated needle or hot glue gun
- Nitrile gloves
- Moisture meters, thermometers, and compost turners
    - Optional - Worm Farm Accessory Kit with Compost Tools (includes moisture meter, pH meter, thermometer, compost turner, food scrap handling tool, and compost harvesting scraper) https://www.amazon.com/Accessory-Wiggler-Composting-Moisture-Thermometer/dp/B00PKJJBWO
- Electronic digital scale with various uses of measurements (g, lbs, oz, ml)
    - Various types of objects to weigh (such as gummy bears, sugar, marbles, and blocks)
    - Small plastic bags or containers for objects to be weighed in

- Beakers for adding water to compost bins when needed
    - Measuring cups or plastic cups can be used as an alternative

Each student needs:
- Chart paper or poster board for cumulative presentations
- A lab notebook and pencil
- Various colored pencils, crayons, and markers

Literature:
- *Compost Stew: An A to Z Recipe for the Earth*
- *Composting: Nature's Recyclers*
- *Yucky Worms*
- *Wiggling Worms at Works*
- *The Little Yellow Leaf*
- *Diary of a Worm*
- Optional book that can be used for teacher's background research or as a class reference - *Compost: A Family's Guide to Making Soil from Scraps*

Lesson Background & Concepts for Teachers
The purpose of this lesson is for students to learn about composting as a natural process, as well as a sustainable practice that can help to reduce food waste. Students will understand the role of invertebrates, such as Red Wiggler earthworms, when decomposing organic waste. During this lesson, students will explore the natural environment with their five senses and use their knowledge of living things and their needs to create a habitat for Red Wigglers. Students will work in teams as they design their habitat in a compost bin, collect data using tools such as a moisture meter and thermometer, and learn about the stages of the engineering design process.

All organic matter, such as living or once-alive plants and animals, rot, or decompose, over time. The organic matter rots into a nutrient-rich soil called humus. This process is called composting. Composting in nature happens slowly as organic matter falls all around a natural environment. For instance, leaves fall to the ground and animals and plants produce waste or die. When designing and using a compost bin in your home or school, you want replicate what happens in nature (or as close as possible). As the organic waste decompose, it becomes food for other organisms, like invertebrates (such as worms) and microorganisms (such as bacteria and fungi). Red Wiggler worms, or Eisenia Foetida, are a common organism introduced into compost bins. Red Wigglers feed on food waste and expel nutrient-rich castings (or worm humus). This humus can then be use for gardening and act as a natural, pesticide free fertilizer. Vermicomposting is a sustainable practice that organically enriches soil, increases plant growth, helps water retention in soil, and most importantly, helps reduce food waste in landfills.

Vocabulary / Definitions

Word	Definition
Living	Things that are or were once alive. Living things can grow, change, reproduce, and have basic needs such as air, water, food, and space. The word 'organic' can be used to describe living or once-alive things.
Nonliving	Anything that is not alive nor has ever been. Nonliving things do not grow, change, or take up space. They do not need food, water, air, or shelter.
Compost	An organic, nutrient-rich soil that is created by decomposed organic materials such as food waste, leaves, and grass clippings.
Organic Waste	Matter that comes from a once-living animal or plant. Examples of organic waste include food and garden or lawn clippings.
Red Wiggler Worm	A species of earthworms that are adapted to decaying organic matter/waste. They are referred to by many common names including, redworm, brandling worm, panfish worm, trout worm, tiger worm, and red Californian earthworm; their scientific name is Eisenia Foetida.
Vermicomposting	The process of earthworms converting organic waste into compost. Red Wigglers break down organic waste into castings.
Castings	Waste produced from Earthworms.
Decomposition	The process of organic materials breaking down, otherwise known as 'rotting.'
Habitat	A natural environment for a living thing that meets its basic needs.
Life cycle	A series of stages of changes in which an organism undergoes, from birth through reproduction.
Soil	The brown or black top layer of Earth that supports life and contains a mixture of organic materials. The three main types of soil are sand, silt, and clay.
Sustainability	The development of habits and practices to limit the use of natural resources and improve our natural environment for future generations.
Pollution	Waste, that is introduced into the environment, which is harmful to plants, animals, and Earth.

Introduction / Motivation

1. Activate background knowledge by telling students that since fall has just begun (or about to begin), you're going do a Think, Pair, & Share with your partner about some changes we see and experience during this season. Allow time for thinking and talking with their partners, as well as opportunities for students to share aloud with the class. When a student shares that leaves fall from trees during the fall, ask the class why this happens.
2. Tell students that today we're going to read a story about a leaf who is afraid of falling. Read *The Little Yellow Leaf* aloud to the class and ask students to observe the changes the other leaves are undergoing as Yellow Leaf holds on.
3. Ask the following questions after the read aloud:
    1. Why do you think Yellow Leaf was afraid of falling?
    2. Have you ever been worried about a change in your life? Was it scary to try something new? How did you feel once you tried it?
    3. What happened to the other leaves during the seasons?
4. If possible, bring students outside near a tree that has a variety of leaves on the ground nearby. Review the main parts of a plant as a class (stem, roots, leaves, and flowers/fruit if any) to activate background knowledge. Tell students they are going to search for their favorite fallen leaf and maybe they'll even find Yellow Leaf.

5. Once each student has found their favorite leaf, ask students to use their senses to describe their leaf in their lab notebook – What does it feel like, smell like, look it, and does it make a sound when you touch it or move it? Allow students to tape or glue their leaf in their lab notebooks. If time permits, students can also write about what they like about their leaf. Provide 10-15 minutes for a group meeting so each student can share their leaf and describe it to their teammates.

6. Afterwards, regroup with students and ask what happens to the leaves after they fall to the ground? If no one picks them up, where do they go? Tell students to think back to the story and what we noticed about the leaves during the fall and winter. Tell students that leaves can be recycled, just like plastic and paper. Tell students that when leaves fall on the ground, they slowly decompose, or rot, and over time become part of the soil. This is called composting. Tell students that during the next couple of weeks they are going to become environmental engineers and learn how to compost!

Activity Overview

Activity 1: Research about composting – Read *Composting: Nature's Recyclers*
Activity 2: Research about Earthworms – Read *Diary of a Worm*
Activity 3: Learning about the habitat of Red Wigglers – *Read Yucky Worms*
Activity 4: Learning about the life cycle, diet, and anatomy of Red Wigglers – Read *Wiggling Worms at Work*
Activity 5: Design a model habitat – Read *Compost Stew*
Activity 6: Practice using lab tools
Activity 7: Collection of materials and building prototype

Activity 8: Observation and data collection
Activity 9: Observation and data collection (redesign and retest if needed)
Activity 10: Observation and data collection (redesign and retest if needed)
Activity 11: Observation and data collection (redesign and retest if needed)
Activity 12: Observation and data collection (redesign and retest if needed)
Activity 13: Observation and data collection and begin working on cumulative presentations
Activity 14: Work on cumulative presentations
Activity 15: Presentations and class results

Procedure for Activity 1

Before the Activity:

- Gather materials: *Composting, Nature's Recyclers*, chart paper, and lab notebook and pencil for every student
- Garbology interactive activity: http://www.naturebridge.org/garbology.php
- An anchor chart with 'reduce, reuse, and recycle' written on it
- Copies of Recycling, Compost, and Garbage Sorting Cards https://www.teacherspayteachers.com/Product/Recycling-Compost-Garbage-Sorting-Cards-3713270

With the Students:

1. Remind students of our story we read, *The Little Yellow Leaf*. Ask students, while Yellow Leaf held on, what happened to the other leaves as the seasons changed? Where did they go? What is the process of recycling leaves in nature? Ask students if they can remember the definition of composting (see Vocabulary/Definitions).
2. Tell students that environmental engineers help change the world by keeping our air, water, and soil clean from pollution (see Vocabulary/Definitions). Tell students that just like environmental engineers do, we're going to brainstorm how we can help keep our Earth healthy. If time permits, watch the video 'What do Environmental Engineers do?' https://www.youtube.com/watch?v=MUT8zya53Vg
3. Remind students of the three best ways we can do this – reduce, reuse, and recycle. Have students share examples of these and write responses on the anchor chart.
4. Tell students, "Before we read our story, I'm going to find out what you might already know about composting and recycling. You're going to learn more about what environmental engineers do by going through waste management training with Garbology." This interactive online activity introduces students to how bacteria, fungi, and invertebrates help aid compost. Garbology also discusses other forms of waste management, such as what gets recycled and how to recycle items properly.
5. Use the interactive website, Garbology, on the Smart Board or Interactive Bright link to practice sorting waste.
6. Tell students that now they're going to be put to the test! Each group is going to practice correctly sorting pictures of waste into the categories: Recycle, Compost, or Garbage (see link above).

7. Pass out cards to each group and allow them to work together as they sort them into the categories. When they're finished, have students raise their hand for you to check their placements. Provide enough time for all groups to finish.
8. Regroup on the carpet and discuss what we learned. What can be recycled? What can be composted? What cannot be composted?
9. Tell students now we're going to learn more about composting – why it's important, how to start and maintain a compost pile, and what animals can help. Read *Composting Nature's Recyclers*.
10. As a class, decide on a definition for 'composting' and provide examples of waste that can and cannot be composted.
11. Optional – Students can write the definition of composting in their science notebooks and make a list of waste that can and cannot be composted.

Procedure for Activity 2

Before the Activity:

- Gather materials: *Diary of a Worm*, chart paper, and lab notebook and a pencil for every student
- KWL chart – What we know, want to learn, and have learned about Red Wigglers
- Anchor chart of living and non-living things

With the Students:

1. Tell students that before they design their own compost bins, they're going to learn about a friendly animal that helps decompose food: Red Wigglers! Tell students that Red Wigglers are a type of earthworm that helps decompose food waste by turning it into rich soil which can be used to help new plants grow. Explain that using Red Wigglers to help decompose food waste is called vermicomposting (see Vocabulary/Definitions). "Red Wigglers eat the food waste, break it down in their body, and expel it as waste (or poop)! This waste is called 'castings.' Castings, along with other living and nonliving things are used as the basis of soil." Ask students, what could we do with this rich soil?
2. Create a KWL chart for Red Wigglers. Fill out 'what we know' and 'want to learn' sections as a class. Tell students that over the next couple of days we're going to conduct research, just like engineers do, to learn more about the life and habitat of Red Wigglers. Tell students that today we're going to begin with a funny story about worms.
3. Read *Diary of a Worm* aloud.
4. Fill in the 'what we learned' section of the KWL chart as a class. Leave space to add to this section for later books/videos about Red Wigglers.
5. What the video, 'Worms are Wonderful!' https://www.youtube.com/watch?v=I-zc_1vjLnI. Add to the KWL chart if time and space permits.
6. After the video, tell students that compost is made of living and nonliving things to help create healthy, rich soil. Ask students what makes something living? Provide a list of students' responses on the anchor chart (needs air, water, food, takes up space, changes). Is a Red Wiggler a living thing? Why? Ask students, what makes something non-living? (doesn't need air, water, food, doesn't take of space or chart). Compile a list of students' responses on the anchor chart.

7. Next, students will do a Think-Pair-Share with a partner as they share examples of living and non-living things. Afterwards, provide a list of students' responses on the anchor chart.
8. Optional – Students can make a list of living and non-living things in their science notebooks. They can observe their classroom environment, as well as a safe outdoor space, to look for living and nonliving things.

Procedure for Activity 3

Before the Activity:

- Gather materials: *Yucky Worms* and lab notebook and pencil
- KWL chart of Red Wigglers from previous activity
- Various colored pencils, crayons, and markers

With the Students:

1. Tell students today we will learn about the habitat (see Vocabulary/Definitions) of Red Wigglers. Tell students that like all living things, Red Wigglers have needs (air, water, food, and space).
2. Read *Yucky Worms*. Add to KWL chart if time and space permits. Ask students to turn and talk to their partner about the three important things a Red Wiggler needs in their habitat. Ask students, how could we build a habitat for Red Wigglers? What would we need to include? Tell students that Red Wigglers, like other earthworms, need moist soil. How can we make the soil moist? What predators would we need to keep our Red Wigglers away from?
3. Optional – The educator can compile a list of students' responses on an anchor chart titled, 'Red Wiggler Habitat,' for students to refer to during the next step.
4. Watch the video, 'Make the Most of Compost!' Ask students to see if they can spot the Red Wigglers in the video: https://www.youtube.com/watch?v=Q5s4n9r-JGU&t=3s
5. Tell students that during the engineering design process, engineers have to imagine their idea before designing it. "Today you're going to draw a model habitat for Red Wigglers in your lab notebooks." Students will color and label the habitat, including what they need to survive, and draw the Red Wigglers that will be in their home. Students will then write 2-3 sentences about what materials they choose to include in their habitat, and why. Students can work in their science notebooks or use the provided worksheet, Model Habitat (see Attachments).
6. Group meeting: Provide time for students to share their habitat drawing and writing with their teammates.

Procedure for Activity 4

Before the Activity:

- Gather materials: *Wiggling Worms at Work*, a pencil for every student, and various colored pencils, crayons, and markers
- Copies of Parts of an Earthworm and Earthworm Life Cycle (pages 14 and 15 respectively) https://www.teacherspayteachers.com/Product/Wormy-Worm-Earthworm-Unit-and-Craft-1825972

With the Students:

1. Tell students that today we're going to continue conducting research about Red Wigglers. Today we will learn about their life cycle, what they eat, and their anatomy (or body).
2. Read *Wiggling Worms at Work*.
3. Tell students that they're going to cut and paste the stages of a worm's life cycle and write what happens first, next, and last. Explain that it's called a cycle because it's a series of changes the animal goes through, which repeats again and again.
4. Pass out 'Earthworm Life Cycle (see link above)' and have students complete in small groups.
5. Next, students will label the parts of an earthworm. Pass out 'Parts of an Earthworm (see link above). As you label the parts as a class, identify the purpose of each part. For example, "The segments on a worm's body help it bend and move." "The posterior is where the castings leave the body." "The anterior has the mouth of the earthworm."
6. Students will glue or staple both worksheets into their lab notebooks.
7. Optional – Teacher can add to previous KWL chart or make a new circle chart about Red Wigglers. This can be useful for organizing information for students to refer back to during the design process.

<u>Procedure for Activity 5</u>

Before the Activity:

- Gather materials: *Compost Stew*: *An A to Z Recipe of the Earth*, a lab notebook and pencil for every student, and compost bedding (cardboard, paper, and newspaper).
- Find optimal locations around the school campus with a variety of natural materials before going on a nature walk.

With the Students:

1. Tell students today we're going to determine what natural materials we will need to build a healthy environment for our Red Wigglers.
2. Read *Compost Stew: An A to Z Recipe for the Earth*.
3. Tell students that their challenge is to design a habitat for Red Wigglers in a compost bin that also decomposes organic waste (see Vocabulary/Definitions). They're allowed to choose three different 'ingredients' from outside to create the perfect compost stew!
4. Tell students that in addition to what they discovered outside, they will also need to write down what type of 'bedding' to include in their compost bin, such as cardboard, newspaper, and paper (have options available). Explain that the bedding helps support the compost, as well as absorbs moisture. Tell students that some bedding materials, like cardboard and newspaper, are food for Earthworms as well!
5. Students can work in their science notebooks, or use the provided worksheet, <u>Materials List</u> (see Attachments), for students to record their three outdoor materials and two bedding materials. Have them think back to what an Earthworm needs to

survive. Remind students that they're only brainstorming what materials they *wish* to include in their bin. Tell students we're not collecting yet, just planning. During the next step, students will narrow down their ideas as a group and decide on their five materials.

6. Tell students that engineers work in groups and so will they! Students will refer to their own materials list and then as a team, decide which five ingredients (including the bedding ingredients and materials from outside) they will use to create their group compost bin. Have students write down their outdoor and bedding materials and collect for later use.
7. Next, tell students that like all engineering designs, there will be controls, or specific things about the bins that will remain the same, and a variable, or the one thing that will be different. Our <u>controls</u> will be: what organic waste is put in the bin, how much organic waste is put in (1 pound), how many worms each bin gets (50), the amount of water added to the bin (200 mL, slightly under 1 cup), 3 natural materials from outside and 2 bedding materials, the total weight of materials (3 pounds), how often we turn the compost, the container used as the compost bin, and location of the bins. Tell students the <u>variable</u> will be the materials their group chooses to use.
8. Optional - write down controls and variable on a whiteboard, Smartboard/ Interactive board, or chart paper and have students copy them in their lab notebook.

<u>Procedure for Activity 6</u>

Before the Activity:

- Gather materials: Nitrile gloves, electronic digital scales, beakers, magnifying glasses, lab notebook and pencil for every student, various types of objects to weigh (such as gummy bears, sugar, marbles, and small wooden blocks), and lab notebook and pencil for every student
- Fill small plastic bags/containers with each object to be weighed (size of bag varies depending on what educator chooses)
- Find a safe, accessible outdoor environment around campus

With the Students:

1. Tell students that all engineers use tools when designing their prototype and collecting data, but it's important they know how to correctly and safety use them first. "Today we will practice using a scale to measure objects, measure liquid in a beaker, and observe objects outside with a magnifying glass. All of these tools will be used when designing our compost bins and collecting data."
2. Tell students that we will measure objects in pounds, which is a unit of measurement used in the United States. Ask students if they have ever been on a scale at the doctor's office to be weighed (show picture if needed)? Tell students that today we're going to be using a smaller scale to weigh objects.
3. Begin by identifying the parts of the scale and describe what they're used for – the weighing platform is used to hold your container and materials as you weigh them, the power button turns the scale on and off, the tare button allows you to put a container on the weighing platform and then set it to zero (this is done because you

want the exact weight of your materials, not the weight of materials and container), and the unit button shows the unit of measurement.
4. Next, model how to weigh objects – turn on the scale, make sure the unit of measurement is set to pounds (lb), put the container on the weighing platform, tare the scale, and add different objects to equal one pound each. Stress the importance of watching the scale as you add materials. Ask students, what should I do when I add too much of the material? What if I put too little? Model these situations.
5. Then, students will work in groups to measure each bag of objects. Students will first tare an empty small plastic bag and then measure every object on the scale. Students will record the weights in their lab notebooks.
6. Optional – Compare the weights of the objects and discuss why some objects are lighter or heavier than others. For instance, why was sugar packed in a small bag heavier than small wooden blocks in a bag?
7. Once finished, tell students that we will now practice using a beaker, which is a tool used to measure liquid. Identity the small 'spout,' or beak, at the top helps pour liquid. Tell students we will practice measuring water in milliliters (mL), which is a unit of measurement used throughout the world. Tell students that the lines on a beaker identity how much water you've measured. Tell students this beaker skip counts by 100.
8. Students will work in groups to measure 100 mL of water and then 800 mL of water.
9. After, tell students we will now practice using a tool called a magnifying glass. Give each student a magnifying glass and provide a couple of minutes of exploration time with it in an outside environment. Regroup and ask students, what does a magnifying glass do?
10. Finally, tell students that engineers often use chemicals or materials that they don't want to touch and keeps them safe. Model how to put on and take off gloves. Provide time for students to practice.
11. Optional - have students draw and label a picture of each tool in their science notebook.

Procedure for Activity 7

Before the Activity:

- Gather materials: Four 12-Quart Clear box used as compost bins, electric drill, various soil, leaves, and natural materials found in an outside environment, cardboard, newspaper, paper, and hay/pine needles to use as bedding, plastic cups, clear plastic bags (1-gallon), 1 pound of organic waste, Red Wigglers, Nitrile gloves, Worm Farm Accessory Kit with Compost Tools – compost turner, electronic digital scales, beakers, and magnifying glasses
- Make air holes (using an electric drill, glue gun, or heated nail) beforehand
- Ensure Red Wigglers are ready to be placed in their new environment the night before. To save on time, it may be necessary to separate 50 worms in four different small containers or bags with soil, food (such as a banana peel), air holes, and water.
- Shred newspaper, paper, and cut cardboard and have them accessible for students. Collect hay/pine needles beforehand.

- Identify a safe, accessible outdoor environment for collecting natural materials. You may want to choose more than one location.
- Separate the same type of food waste and the same amount (1 pound) for each group. You can store organic waste in the freezer before they're ready to be used.
- Identify a safe, dark location for compost bins.

With the Students:

1. Design day! Tell students that today they will collect their materials and design their compost bins.
2. Provide each group with a 1-gallon bag and tell students that they will be using this bag to collect their materials. Remind students their materials have to weigh no more or less than 3 pounds, and their materials will include 3 from an outside environment and 2 for the bedding.
3. Group meeting – allow time for students to look back at their list of materials they will be collecting today (from Activity 5).
4. Students will collect materials from outside and then add bedding materials to their bags. Students will put on gloves before collecting materials. Students can use plastic cups to collect materials.
5. When finished, students will weigh their bags to determine if it equals 3 pounds. Remind them of the procedure of weighing objects (have an empty bag nearby so they can tare it first). Students may need to add or take out materials.
6. Once students have added their materials to their bin, students will then add the organic waste and bury it in their bin.
7. Next, the teacher will add 50 worms to each compost bin. Give students time to observe the worms. Students can use their magnifying glasses as they observe.
8. After, students will add 200 mL of water to their bin.
9. Model how to turn the compost bin with the compost turner and allow students to turn their compost. Tell students we will turn the compost pile every couple of days to make sure it's getting enough air. Have students safely remove gloves.
10. Teacher can place bins in their designated location.

<u>Procedure for Activity 8</u>

Before the Activity:

- Gather materials: Worm Farm Accessory Kit with Compost Tools – moisture meter and thermometer for data collection, magnifying glasses, Nitrile gloves, beakers if adding water to compost if necessary (check moisture level), bedding or natural materials for redesigning, lab notebook and pencil for every student.
- Attach each group's materials list to the outside of their compost bins as a reminder of what materials were used.
- Write materials that were used on the top of the bin next to the picture.

With the Students:

1. Tell students that engineers keep detailed notes about their observations and collect data using tools. "During the next week we will observe the behaviors of the

Red Wigglers and changes in our compost bins, and record how much moisture (or water) is in the soil and the temperature of the bin."

2. Have students create a chart with 3 sections in their lab notebooks. Title the sections: moisture, temperature, and observations.
3. Tell students that just like we don't like to be too hot or too cold, the soil in the compost bin has to be between a specific range of temperatures for the Red Wigglers to stay healthy.
4. Show students the thermometer. Tell students the yellow section (between 60° F and 80° F) is perfect for Red Wigglers – not to cold and not too hot. Point out that the picture of the worm in this range looks happy and healthy. Identify the red sections on the thermometer mean the temperature of the compost is too hot, and the blue sections indicate the temperature is too cold. Ask students, what could cause the compost bin to get too cold/hot?
5. Next, tell students that Red Wigglers, like all living things, need water to survive. But too much water can hurt the Red Wigglers. Remind students that earthworms breathe through their skin and too much water will cause a lack of air in the bin. Tell students the green range of moisture is what we want (from 4 to 7). A range of 1-3 means there isn't enough water in the bin, and a range of 8-10 means there is too much water in the bin. Ask students, what would you do if your moisture meter was at a 2? What if it was at a 9?
1. Next, students will put on gloves before they open their compost bins. Then, students will collect their data using the moisture meter and thermometer and use magnifying glasses to observe the soil and Red Wigglers. Students will record their data in their lab notebooks. Students will create a chart with 3 sections in their science notebooks, moisture, temperature, and observations, to record their data. The observation section can include words and pictures of what they see in their compost bin. They can also note any changes, problems, or successes.
6. Students may need to redesign if they notice a 'problem' in their bin (see Troubleshooting Tips). Students can add water or natural materials/bedding if necessary. When finished, students will safely remove gloves.

Procedure for Activity 9

Before the Activity:

- Gather materials: Worm Farm Accessory Kit with Compost Tools – moisture meter and thermometer for data collection, magnifying glasses, Nitrile Gloves, beakers if adding water to compost if necessary (check moisture level), bedding or natural materials for redesigning, and lab notebook and pencil for every student.

With the Students:

2. Students will create a chart with 3 sections in their science notebooks: moisture, temperature, and observations.
3. When ready, students will put on their gloves and collect their data using the moisture meter, thermometer, and magnifying glasses.
4. When finished, students will safely remove gloves.

5. Afterwards, students will have a group meeting - What is happening in your compost bin? Has anything changed? What are the worms doing? What is working and/or not working?

Procedure for Activity 10

Before the Activity:

- Gather materials: Worm Farm Accessory Kit with Compost Tools – moisture meter and thermometer for data collection and compost turner, magnifying glasses, Nitrile Gloves, beakers if adding water to compost if necessary (check moisture level), bedding or natural materials for redesigning, and lab notebook and pencil for every student.

With the Students:

1. Students will create a chart with 3 sections in their science notebooks: moisture, temperature, and observations. Remind students they will need to make a new chart every time they collect their data. Tell students to write the date on the page every time as well.
2. When ready, students will put on their gloves and collect their data using the moisture meter, thermometer, and magnifying glasses.
3. Today, students will turn the compost. When finished, students will safely remove gloves.
4. Afterwards, students will have a group meeting - What is happening in your compost bin? Has anything changed? What are the worms doing? What is working and/or not working?

Procedure for Activity 11

Before the Activity:

- Gather materials: Worm Farm Accessory Kit with Compost Tools – moisture meter and thermometer for data collection, magnifying glasses, Nitrile Gloves, beakers if adding water to compost if necessary (check moisture level), bedding or natural materials for redesigning, and lab notebook and pencil for every student.

With the Students:

1. Students will create a chart with 3 sections in their science notebooks: moisture, temperature, and observations.
2. When ready, students will put on their gloves and collect their data using the moisture meter, thermometer, and magnifying glasses.
3. When finished, students will safely remove gloves.
4. Afterwards, students will have a group meeting - What is happening in your compost bin? Has anything changed? What are the worms doing? What is working and/or not working?

Procedure for Activity 12

Before the Activity:

- Gather materials: Worm Farm Accessory Kit with Compost Tools – moisture meter and thermometer for data collection and compost turner, magnifying glasses, Nitrile Gloves, beakers if adding water to compost if necessary (check moisture level), bedding or natural materials for redesigning, and lab notebook and pencil for every student.

With the Students:

1. Students will create a chart with 3 sections in their science notebooks: moisture, temperature, and observations.
2. When ready, students will put on their gloves and collect their data using the moisture meter, thermometer, and magnifying glasses.
3. Today, students will turn the compost. When finished, students will safely remove gloves.
4. Afterwards, students will have a group meeting - What is happening in your compost bin? Has anything changed? What are the worms doing? What is working and/or not working?

Procedure for Activity 13

Before the Activity:

- Gather materials: Worm Farm Accessory Kit with Compost Tools – moisture meter and thermometer for data collection, magnifying glasses, Nitrile Gloves, beakers if adding water to compost if necessary (check moisture level), bedding or natural materials for redesigning, lab notebook and pencil for every student, chart paper or poster board, and various colored pencils, crayons, and markers.

With the Students:

1. Tell students that today is our last day for recording data and observations.
2. Students will create a chart with 3 sections in their science notebooks: moisture, temperature, and observations.
3. When ready, students will put on their gloves and collect their data using the moisture meter, thermometer, and magnifying glasses.
4. When finished, students will safely remove gloves.
5. Group meeting - What happened in their compost bin during the week? Was it successful or unsuccessful? How do you know? What materials worked best? How do you know? If you were able to build a new prototype, what would you do differently?
6. Tell students that engineers communicate their results with other engineers and scientists. "Today you will start working on your final presentation as a group. In two days, you will present and communicate your results with the rest of the class."
7. Give students a piece of chart paper or poster board. Supply various colored pencils, crayons, and markers.
8. Tell students they can organize and decorate their poster any way they'd like, but it must include these four components: Materials (and explanation of why they were

chosen), Data Collection, Observations (include any changes, problems, and success), and Redesign (what would you do differently next time? How would you redesign?)
9. Allow time for students to work on their presentation as a group.

Procedure for Activity 14

Before the Activity:

- Gather materials: Chart paper or poster board, Various colored pencils, crayons, and markers, Lab notebook and pencil for every student

With the Students:

1. Students will continue to work on presentations as a group.
2. Tell students that when engineers present their findings, they often use pictures. Encourage students to include pictures in their poster.
3. Remind students to look back in their lab notebooks at their data and observations.

Procedure for Activity 15

Before the Activity:

- Gather materials: Chart paper or poster board, Various colored pencils, crayons, and markers, Lab notebook and pencil for every student

With the Students:

1. Provide time for students to finish their posters.
2. Each group will present to the class and the teacher will use the given rubric (see Attachments) to grade each group's presentations.
3. Afterwards, regroup with students and ask the following questions: What did we learn about Red Wigglers during this process? What did we learn about composting? How does composting help keep our Earth healthy?
4. Tell students that composting is a sustainable practice, which means it's a habit and practice that can improve our natural environment and make our Earth a greener, healthier place to live. Tell students we can continue to use our compost bin by feeding the Red Wigglers organic waste from the cafeteria and/or school garden.

Figure 2

Image file: IMG_2129.jpg

ADA Description: Image of three students working together as they add food waste (banana peels, broccoli stems, and old fruit) into a compost bin. The compost bin includes leaves, dirt, and twigs.

Source/Rights: Andrea Chavez

Caption: Adding food waste into a compost bin!

Attachments

1. Model Habitat
2. Materials List
3. Presentation and Poster Rubric

Safety Issues

Students should always use gloves when handling food waste, compost, and the Red Wiggler worms. However, discourage handling of Red Wigglers as much as possible. Ensure students wash their hands before and after.

Avoid adding dairy and meat products, and greasy foods to the compost bin, as it will attract unwanted vermin and pests.

To ensure the Red Wigglers stay safe, model how to safely and carefully turn the compost, insert the moisture meter and thermometer, and add the natural materials/organic waste into the bins.

Troubleshooting Tips

Wait until you're ready to begin the design challenge to buy the Red Wigglers. Once they arrive, they need to be immediately introduced in their new environment, given food and water, and time to settle into their new home.

The more Red Wigglers you add to the bin, the more space and organic waste they will need. Due to the size of the clear bins and possible time restrictions, I suggest limiting each compost bin to 50 worms. You can create a control compost bin with additional worms if necessary.

Ensure the natural materials the students choose from outside have not been treated with pesticides, as they can very harmful to the Red Wigglers. Watch out for other insects as well!

If students choose to add paper, cardboard, or newspaper to their compost pile, offer paper that is not bleached (white copy paper) or has a glossy finish (flyers, magazines). Most newspapers use soy-ink and should not be an issue for the worms; however, you can soak the shredded newspaper in water before letting students add it to their bins.

Any type of soil or natural material being used should not have synthetic fertilizer (plant food) added to it. The compounds in these fertilizers are not healthy for the Red Wigglers.

Common issues with compost bins:

- The presence of fruit flies. This is caused by too much organic waste and/or organic waste being added to the top of the surface instead of being buried.
- Unpleasant odors from the bin! This is caused by giving your worms too much food waste or too much water.

- Worms crawling out of the bin. This happens when the environment is not meeting the Red Wigglers' basic needs for survival.

If any of the above issues occur, provide students will relevant information and allow them to redesign by adding necessary components/materials to their compost bin design. Encourage students to conduct research, observe the other compost bins, and problem solve with peers. Have students review previous data, observations, and pictures as well. Additionally, have students record the changes in their moisture meter and thermometer, which could reflect the cause of the issue.

Assessment

Pre-Activity Assessment: Pre-assessments conducted using the Recycling, Compost, and Garbage Sorting Cards and KWL Chart of Red Wigglers.

Activity Embedded Assessment: Research and data collection in lab notebooks.

Post-Activity Assessment: Each group will make a poster about their compost bins, with the following components: ingredients used, successes, problems, and changes for next time. Each group will present their poster to the class.

Activity Extensions

- Students can create a presentation to persuade cafeteria staff, administrators, and/or other teachers and grades levels to start a school compost bin. Students can present their data, what they learned, the importance of composting, and how it would benefit the school community.
- Use pictures and data to create a class book about how to compost with Red Wigglers. Students can write about their own experiences and include tips for composting success.
- Students can watch the Magic School Bus Meets the Rot Squad as a cumulating video about the process of decomposition and how decomposers recycle once-living things.

Activity Scaling

- For higher grades (3-5), students can be given a budget for materials and through independent research, determine the best option for their design.
- When collecting data, students can observe and determine the relationship between temperature, humidity, and composting, as well as determine the ratio of water to soil.
- Students can observe compost soil at different stages under a microscope to better understand the role of fungi, bacteria, and invertebrates.
- Students can identify types of natural resources (renewable and nonrenewable) and how they impact the environment, and learn about how compost is used, in local practice and industry, to limit pollution and greenhouse gas emissions.

- Students can write a letter to their local government to discuss how composting can benefit their community, as well as how their city/town/neighborhood can begin a compost program.

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Supporting Program

Multidisciplinary Research Experiences for Teachers of Elementary Grades (PI: Prof. Chelsey Simmons), Herbert Wertheim College of Engineering, University of Florida.

Acknowledgments

This curriculum was developed under the National Science Foundation EEC grant no. 1711543. However, these contents do not necessarily represent the policies of the NSF, and you should not assume endorsements by the federal government.

Testing Information

Coming soon!