Worm Your Way Out of This!

Grade 3

Standards
GPS.S3E1c S3L1 c, d S3L1b
NGSS.3LS1.C, 3ETS1.A,B,C

Time
(3) 45 min periods + ongoing projects

Supplies
(per student)
- 1 red wriggler worm
- 1 magnifier
- 1 bug catcher or paper bowl
- Internet-connected computer
- Worm Investigation Lab Report
- Soil Investigation Lab Report
- Vermicompost Experiment Report

(per group of 4 students)
- specimens of sand, vermicompost (from worm container), garden soil
- spray bottle
- ruler or measuring tape
- worm bin (shallow plastic tub with lid, drill, screen mesh, duct tape)
- sanitizer or hand soap and towels
- bedding ie paper from recycling bin
- sand, garden soil, & vermicompost
- gloves for handling compost
- serrated cake server for dicing food

Garden Connection
Students will make vermicompost from lunch scraps and contribute "finished" compost to the school garden to improve soil health. Students will also compare garden soil to sand and to vermicompost, and conduct experiments in the garden to determine the value of vermicompost.

Overview
Third grade students will learn how they can minimize food waste and turn lunch leftovers into vermicompost to improve soils in the school garden.

Engaging Students
Students will be introduced to the problem of too much garbage being disposed of in landfills and monitor the garbage generated by their school at lunch to see how much food waste contributes to this problem. Students will watch a film about one school's solution, view time lapse films of decomposition, and play an interactive computer game to learn more.

Exploration
Investigating Worms: Up Close and Personal
Each student will investigate a worm by observing it carefully, measuring it, sketching it, and researching it online.
Investigating Soils
Students will observe and compare sand, garden soil and vermicompost to discover that more fertile soils have organic matter mixed in with minerals.
Making Worm Compost
Students will collect lunch waste from class (or school) and use it to feed worms and create vermicompost.
Experiment on Vermiculture Fertilizing the Garden or Reducing Food Waste
When vermicompost is black and crumbly, students will apply it to the garden, and conduct experiments to assess the value of vermicompost.

Explanation
Students will be able to explain soil components, how compost enriches soil, benefits plants, and how composting reduces waste.

Environmental Stewardship
Students will use what they learned about worms, decomposition and compost in this lesson to report the first earthworm of spring to a national citizen science database; enhance the fertility, structure and water-holding capacity of garden soil by adding finished compost; and design and conduct an experiment about growing plants in vermicompost-enriched soil compared to other soils, or other types of compost, or different ratios of soil to compost.

Evaluation
A Lab Report and rubric are provided to assist in assessing student proficiency.

Standards

Georgia Performance Standards in Science

Earth Science

S3E1. Students will investigate the physical attributes of rocks and soils.

c. Use observation to compare the similarities and differences of texture, particle size, and color in top soils (such as clay, loam or potting soil, and sand).

Life Science

S3L1. Students will investigate the habitats of different organisms and the dependence of organisms on their habitat.

c. Identify features of animals that allow them to live and thrive in different regions of Georgia.

d. Explain what will happen to an organism if the habitat is changed.

S3L2. Students will recognize the effects of pollution and humans on the environment.

b. Identify ways to protect the environment.

- Conservation of resources
- Recycling of materials

Next Generation Science Standards

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

When the environment changes in ways that affect a place's physical characteristics, temperature or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)

ETS1.A: Defining and Delimiting Engineering Problems

Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)

ETS1.B: Developing Possible Solutions

Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)

At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)

Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

ETS1.C: Optimizing the Design Solution

Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

Background Information

Worm Composting Basics from Cornell: http://compost.css.cornell.edu/worms/basics.html

Soil invertebrates: http://ei.cornell.edu/teacher/pdf/D%26R/D%26R_Soil_Invert_ID.pdf

Converting Food Waste to Compost: http://www.ct.gov/dep/lib/dep/compost/compost_pdf/schmanual.pdf

Cafeteria Rangers reduce school lunch waste: http://www.cafeteriawastereduction.com/CWR/HOME.html

School Compost guide: http://www.ct.gov/dep/lib/dep/compost/compost_pdf/schmanual.pdf

Criteria for student-designed experiments: http://www.biologycorner.com/worksheets/labreport_rubric.html

Teacher Preparation

- Make a copy for each student of the Worm Investigation Lab Report and Soil Investigation Lab Reports (back to back)
- Obtain the necessary supplies and materials for this lesson.
- Be prepared to introduce the problems of too much solid waste (garbage) and soil nutrient depletion in the garden, as well as the potential of worms to solve both problems. (See Background Information, if necessary).
  - Arrange with cafeteria staff in advance, when and how students will count bags of garbage collected at lunch.
  - Preview this film in advance to decide how much to show of one school's story of their efforts to reduce cafeteria waste: this film about reducing cafeteria waste: https://www.youtube.com/watch?v=g2vGlSNbPYQ

- Arrange to show YouTube film of rotting fruits and vegetables: https://www.youtube.com/watch?v=c0En-_BVbGc and of pumpkins and apples decomposing in a compost heap: https://www.youtube.com/watch?v=RYssw7gvD_s
- Determine whether Adventures of Vermi the Worm interactive game should be downloaded to hard drive of student accessible computers or played online. Both options: http://www.calrecycle.ca.gov/vermi/

- Build a worm bin by drilling /poking air holes in the lid of a dark-colored, shallow 10 gallon bin. Tape screen on top.
  - OR a multi-level worm bin is even more effective, because completed compost can be separated from newer decomposing materials and the design allows for drainage (or collecting of "compost tea") from the bottom.
    - 2-3 level bucket system: http://www.treehugger.com/green-food/make-a-cheap-worm-bin-from-buckets-video.html
    - 2 level plastic tub system: http://whatcom.wsu.edu/ag/compost/easywormbin.htm
- Arrange for students to have internet access for research, or display worm research information for class.
- Prepare students to conduct inquiry investigations and to design experiments, using the following resources.
  - Science Fair Project Guide: http://www.sciencebuddies.org/science-fair-projects/project_guide_index.shtml?From=Tab
  - Independent and Dependent (Responding) Variables: http://www.biologycorner.com/physics/scimethod/scimethod_variables.html
  - Identifying Controls and Variables with the Simpsons: http://www.biologycorner.com/worksheets/controls.html
  - Fair Tests: A Do It Yourself Guide: http://undsci.berkeley.edu/article/0_0_0/fair_tests_01
  - Lab Report Rubric for Assessing Experimental Design: http://www.biologycorner.com/worksheets/labreport_rubric.html
- Always emphasize to students that hands must be washed after touching dirt (more because of soil bacteria and microorganisms than worms). Gloves should be worn when handling compost.

PROCEDURES FOR LESSON ACTIVITIES

Day 1

Engaging Students

- Ask students to guess how much trash the average person in the U.S. generates every day (4.6 lbs!). Count bags of garbage collected after lunch time in the school cafeteria. Share information on problems of creating too much garbage: http://www.learner.org/interactives/garbage/solidwaste.html
- Explain that time lapse photography is a way of capturing an image every few minutes so that when shown together, it appears to be a movie that condenses things into a shorter period of time. Show the rotting vegetables and rotting compost and worm compost time lapse films to start a conversation about decomposition, soil composition, and worms. Decomposition releases trapped nutrients and creates healthy soil.
  - Rotting fruits and vegetables: https://www.youtube.com/watch?v=c0En-_BVbGc
  - Pumpkins and apples decomposing in a compost heap: https://www.youtube.com/watch?v=RYssw7gvD_s
  - Worms decomposing food scraps: https://www.youtube.com/watch?v=g2vGlSNbPYQ
- Show students this film about reducing cafeteria waste: https://www.youtube.com/watch?v=g2vGlSNbPYQ
- Play an interactive computer game called *The Adventures of Vermi the Worm*, to learn about vermicomposting as one (partial) solution. http://www.learner.org/interactives/garbage/solidwaste.html

Exploration

Worm Investigation Lab

- Provide each student with a Worm Investigation Lab Report.
- Give each student an earthworm gathered from worm bin or garden soil, or a red wriggler obtained from local bait store. (Please do not purchase night crawlers for students to observe, as they are non-native and do more harm than good when released. Note that red wrigglers can be purchased at 24 hour discount department stores in sporting goods).
- Students will investigate a worm by observing it carefully, measuring, sketching, and thinking of questions to research.
- Students will research worms based on their own questions, at Journey North web site: http://www.learner.org/jnorth/search/Worm.html
- If Internet-connected computers are not available, the teacher can print the Frequently Asked questions from this web

site, in the categories of Characteristics, Life Cycle, Ecology, and Conservation OR share the web site via Smartboard.

- Additional optional student research site: http://www.wormdigest.org/content/view/35/2/
- Give each student a chance to share one or two facts from their research with the class, OR create a class book on worms, with each student contributing their lab sheet as a page in the book.

Day 2

Soil Investigation Lab

- Divide the class into teams of four.
- Provide each student a magnifier (hand lens) and a copy of the Soil Investigation Lab Report (preferably copied on back side of Worm Lab Report).
- Give each team three marked soil specimens to observe: sand, garden soil and vermicompost. (Some worm castings from containers of red wrigglers –including a few worms -can serve this purpose, if worm bin is not yet productive.)
- Encourage students to compare the components of the soil specimens. Students should be able to observe that sand is mineral soil with little organic matter; garden soil may have observable leaf bits and soil critters, and vermicompost is richest with nutrients.

Making Worm Compost (Vermicomposting)

- Daily or weekly, students will add shredded paperor pieces of cardboard, finely chopped food waste (fruit and veggies only), leaf litter and a sprinkling of water to dampen ingredients in bin.
- Students will feed and care for the worms on a rotating basis, as assigned. This includes keeping a record of time and location (bin quadrant) where organic or bedding matter is added to bin.

Day 3 (approximately two months after vermicomposting is started, when finished compost is available)

Environmental Stewardship

Fertilizing the Garden and Growing Plants

- Stop adding food waste to worm bin 2 weeks before desired compost completion (after at least two months).
- Determine when compost is finished using this criteria: http://sarasota.ifas.ufl.edu/compost-info/tutorial/compost-maturity-test.shtml
- Students can add finished compost to garden soil and mix in gently, keeping one area or bed free of compost for control (comparison) purposes in experiments.

Extensions

Conducting Experiments with Vermicompost

- Students may carry out the experiments they designed to learn about vermicompost and soil health or plant growth
- Divide students into small groups, if desired, to complete a few select student-directed experiments.
- Provide information on experimental design and scientific method, as necessary. See Teacher Preparation section
- Students will conduct experiments to test the effectiveness of their vermicompost in terms of plant productivity, soil fertility, soil water holding capacity, etc. Alternatively, students may design projects to see how long specific waste items take to decompose in the vermicompost bin.

Cafeteria Waste Reduction

- Students may wish to expand their vermicomposting to include wider or whole-school participation
- Students may wish to compare the amount of garbage generated at lunch after vermicomposting started
- Students may wish to choose and implement other strategies and solutions for reducing cafeteria waste

Citizen Science Research on Earthworms and Seasons

- Students may contribute to a nation-wide database tracking the first sighting of an earthworm in Spring, across the country, at this web site: http://www.learner.org/jnorth/tm/worm/About.html

Vermicomposting Explorations and Student Research Opportunities

- Vermicomposting Classroom activities: http://www.calrecycle.ca.gov/Education/Curriculum/Worms/98Activities.pdf
- Identifying other organisms living in vermicompost: http://ei.cornell.edu/teacher/pdf/D%26R/D%26R_Soil_Invert_ID.pdf
- Other types of compost: http://www.weblife.org/humanure/chapter3_10.html

Worm Investigation Lab Report

Name: _____ **Date:** _____

NOTE: Worms require moist skin. Please occasionally spray or sprinkle worms with water while observing. Return worm to soil after investigation is over.

1. Sketch of worm with labeled parts: head, clitellum, tail

2. Worm measurements

Length: _____

 # segments from head to clitellum: _____

3. Questions I have about worms (things I want to find out):

_____

_____

Worm research web sites:

- **http://www.learner.org/jnorth/search/Worm.html**
- **http://www.wormdigest.org/content/view/35/2/**

4. Interesting things I learned about worms from the computer or books:

_____

_____

_____

Soil Investigation Lab Report

Name: _____ **Date:** _____

1. **What I saw when I looked at SAND with a magnifier:**

2. **What I saw when I looked at GARDEN SOIL with a magnifier:**

3. **What I saw when I looked at vermicompost with a magnifier:**

4. **What are the benefit of vermicompost?**

   a. _____

   b. _____

My Vermicompost Experiment

Name: _____

Date: _____

What question will be answered by this experiment? (Example: How will _____ be affected by __?)

_____

What is the hypothesis to be tested? (What do you think the answer is to the question above?)

_____

What is the independent variable? (What is the one thing you will change or test in this experiment?)

_____

What is the dependent variable? (What will you measure, to see what the results of the experiment are?)

_____

What are the controlled variables? (What are the things will you try to keep the same, to make it a fair test?)

_____

What procedures will you follow? (What are the steps you will follow to do this experiment?)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

(Now conduct the experiment)

What happened? (What were the results of the experiment?)

_____

What does this result make you wonder about?

_____

Assessment for Worm Your Way Out of This

Student Name(s): _____ **Date:** _____

Level of Mastery / Benchmark or Performance Measure	 **EMERGING** **Not yet proficient** **1 point**	 **COMPETENT** **Partially proficient** **4 points**	 **PROFICIENT** **Mastered task** **5 points**	**TOTAL POINTS**
Worm Investigation	Student sketched and measured worm but Lab Report was incomplete.	Student sketched and measured worm and identified at least one question and found one research fact.	Student sketched and measured worm and identified multiple questions and multiple research facts.	
Soil Investigation	Student drawings did not identify soil components and list no benefits of vermicomposting.	Student drawings identify components including mineral soil, living organisms and decayed bits of leaves in garden specimen and vermicompost (but not sand) and list a benefit for vermicomposting: reducing garbage or improving soil health	Student drawings identify components including mineral soil, living organisms and decayed bits of leaves in garden specimen and vermicompost (but not sand) and list 2 benefits for vermicomposting: reducing garbage and improving soil health	
Vermicomposting	Student contributes to vermicomposting but cannot explain how it works, why it is being done or where finished compost will go.	Student dices or shreds appropriate lunch scraps (no meat or dairy) and buries scraps in bedding in the worm bin, sprinkling enough water to dampen it all, and can explain that worms eat scraps and bedding and make castings (poop).	Student does everything in box to left; explains that vermicompost reduces food waste (or garbage) and recycles nutrients from the plants and food scraps worms eat, and –when added to garden – improves soil health and plant health.	
Experimental Design	Student's experimental design is incomplete or questions on Lab Report are not answered appropriately.	Student's experimental design is complete but is not a "fair test" of how vermicompost affects soil and / or plants in the garden.	Student's experimental design is complete and a "fair test" of how vermicompost affects soil and / or plants, correctly listing control, independent variable and dependent variable.	