Extreme Makeover – Landfill Edition

Objective:

The purpose of this lesson is to design a state-of-the-art landfill to be placed within the county that will take into account recycling and composting products.

Keywords:

- Waste management
- Composting
- Aerobic digestion

21st Century Skills Represented:

- Environmental Literacy
- Creativity
- Critical Thinking

National Science Education Standards:

- Physical Science: Matter & its Interactions
- Earth & Space Sciences: Earth & Human Activity
- Engineering Technology & Applications of Science: Engineering Design; Links Among Engineering, Technology, Science & Society

feedstocks	processes	uses
Municipal solid waste	Biological - composting	Fertilizer/soil amendments

Background

Where does your garbage go? What happens to all the waste? Check out these facts:

- The average American discards 4.34 pounds of garbage every day.
- Five PET bottles (plastic soda bottles) yield enough fiber for one extra-large t-shirt, one square foot of carpet or enough fiber fill to fill one ski jacket.
- An average kitchen-size bag of trash contains enough energy to light a 100-watt light bulb for more than 24 hours.

Recycling not only reduces the waste that ends up in our landfills, it also conserves natural resources, which means cleaner land, air and water. Check out these facts:

- Recycling glass uses 40 percent less energy than is necessary to make new glass.
- It requires 40 percent less energy to make paper from recycled paper than it does to make paper from fresh lumber.
- Recycling plastics uses as much as 70 percent less energy than is necessary to make new plastics.
- Recycling aluminum uses 95 percent less energy than is necessary to make new aluminum.

Composting is a method for treating solid waste in which organic material is broken down by microorganisms in the presence of oxygen to a point where it can be safely stored, handled and applied to the environment. Composting is an essential part of reducing household wastes. Methane and other gases are produced as landfill waste decomposes. More than 75 percent of the methane can be made available for use as "green" energy. Methane is generated in landfills and open dumps as waste decomposes under anaerobic (without oxygen) conditions. The amount of methane created depends on the quantity and moisture content of the waste and the design and management practices at the site. According to the EPA, America's solid waste industry produces enough electricity and methane gas from landfill gas to light and heat nearly 1.6 million homes. Chemists, biologists, geologists, civil engineers, hydrologists and other science and technology experts at solid waste companies are turning this bioconversion process into a fuel and energy source while protecting the environment. It is an industry of STEM careers.

Materials

Per group of 2-3 students:

- Poster boards
- 2-liter bottle
- Compost mixture filling at least ½ of bottle:
  - 3 parts "green" materials (e.g. grass clippings, vegetables, coffee grounds, etc.)
  - 1 part "brown" materials (leaves, stems, straw, paper, etc.)
  - Enough outdoor dirt to add a 1 cm layer
- 250 mL distilled water
- Wooden stir sticks
- Thermometer
- Scissors
- Permanent marker
- Paper towels

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Pre-Lab Preparation

1. Have students research and answer the following questions:
    a. What is waste management? How does it work?
    b. What is recycling? How does it work?
    c. What is a landfill? How does it work?
    d. How do landfills contribute to groundwater contamination?
    e. How do landfills affect soil?
    f. What is aerobic respiration? How does it work?
    g. What is composting? How does it work?
    h. How are aerobic respiration and composting related to one another?
2. Have students visit the following website and record their observations on the garbage cycle.
    a. http://www.environmentalistseveryday.org/solid-waste-management/green-environmental-waste-collection-recycling-process/index.php
3. Hold a class discussion over the questions and the garbage cycle.
4. Divide students into groups of 2 or 3.
5. Have each group bring in: a clear 2-liter bottle, "green" material to be composted and "brown" material to be composted.

Lab Procedures

1. Have the students gather into their groups and perform the following tasks.

Part 1: Make a mini-compost bin:

a. Use a permanent marker to put their names, date, and class period on the bottle.
b. Cut the top of the 2-liter bottle off so they can add their "green" and "brown" materials.
c. Poke holes in the bottom of the 2-liter bottle to allow for drainage.
d. Add their compositing materials to the bottle in the ratio of 3 parts "green" to 1 part "brown".
e. Fill the bottle so that it is about ½ to ¾ full.
f. Add a layer of dirt approximately 1 cm thick on top of the compost material.
g. Add 250 mL of distilled water to the mixture and place the bottle on top of a paper towel.
h. Using a stir stick, thoroughly mix the contents of the bottle.
i. Take the temperature of the mixture and have students record it in their notebooks.
j. Store their mini-composting bin in the classroom.
k. For the next few weeks, have students periodically mix the contents of their bottle, add water, and take the temperature of the mixture.
l. Students should record the temperature of the mixture, amount of water added and their observations of the composting process throughout the experiment.

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Part 2: Designing a landfill:

1. Provide each group with a piece of poster board.
2. Have each group design their own modern, state-of-the-art landfill for their county.

When designing their landfill students should take into account:

a. Placement and community/political concerns
b. Environmental issues, including groundwater contamination, run-off, soil quality, etc.
c. Sustainability issues, including the proximity of a recycling center and composting facility.
d. Consideration of all long-term effects of the landfill, and the process of building it from start to finish.

3. When finished each group will present their final projects to the class.

Post-Lab Discussion/Questions

1. Have the students answer the following questions:
    a. What did you learn about composting?
    b. Did your mini-composting bin work well? Why or why not?
    c. What could you use your compost for?
    d. How does composting help the environment?
    e. How does composting help landfills?
    f. What was your landfill design?
    g. How did it meet community/political needs?
    h. How did it meet environmental needs?
    i. How did it meet sustainability needs?
    j. How can people reduce the amount of waste they send to a landfill?
2. Hold a class discussion over the questions and their answers.

Expansion Ideas

- Have students test different variations of composting, such as wet versus dry, nitrogen rich verses nitrogen poor, and oxygenated verses oxygen depleted.
- Have students present their final landfill projects to a community panel, which can include school administration, county extension agent, local businessmen and women, farmers, and waste management administrators.
- Use the compost from the mini-composters as a medium to plant seeds.

Evaluation of Learning

- Students were able to successfully observe and document the composting process.
- Students turned in their observations and answers to all questions.

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Resources

- Websites and Articles
  - Know Your Trash Facts by Environmental Industry Association
  - Where Does Methane Come From? by the U.S.E.P.A.
  - How Compost Works by Squidoo
  - Waste-based Renewable Energy by Environmental Industry Association
  - Where Does Garbage Go? by Environmental Industry Association

Contacts

- quasar energy group Headquarters, Cleveland, OH: http://www.quasarenergygroup.com/
  - quasar Laboratory & Engineering, Wooster, OH
  - Operational Digesters: Wooster, Columbus, and Zanesville
  - Commissioning Digesters: North Ridgeville
- SWACO, Solid Waste Authority of Central Ohio, Grove City, OH: http://swaco.org/
  - Education page, including landfill tours: http://swaco.org/SmartKids.aspx
- Rumpke, Cincinnati, OH: http://www.rumpke.com/
  - Education page, including landfill tours: http://www.rumpke.com/education

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