Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1992 Volume V: Ecosystems: Tools for Science and Math Teachers

Organic and Inorganic Recycling

Curriculum Unit 92.05.08
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Introduction

Humans played a major role in environmental pollution for many years and now that the damage is clear we have started the clean up process. People became accustomed to throwing things “away” and never realized where “away” was. Waste is something left over or not used. Solid waste was thrown away into trash containers, dumped into landfills, compacted and covered with dirt. It was assumed that the garbage would break down and mix with the soil. However, over the years the garbage became a major problem. It wasn’t breaking down and landfills were beginning to overflow. This overflow of garbage in the landfills can lead to the release of hazardous gases and can contribute to water pollution. The realization that our planet was fragile and our environment was in danger became apparent. Attempts to preserve the environment became a priority. This unit is divided into four sections. The introduction provides students with an awareness of “waste” and the present environmental dilemma. The first section presents an overview of recycling and its benefits. The next two sections discuss composting as a method of recycling and using earthworms as nature’s recycler. The unit is designed for students in grades five through eight and can be used as a supplement to the existing science curriculum. Through the information provided in the background text and lesson plans the student will:

1. Identify the similarities and connections between natural and human recycling.
2. Discover the importance of recycling and the preservation of natural resources.
3. Learn about the biochemical process of decomposition and compost piles.
4. Study and observe the earthworm as one of nature’s important recyclers.

About twenty years ago communities began to make their citizens aware of threats to the environment. At the same time legislators started to enact laws and regulations to protect and preserve the environment. The need to teach about changing our wasteful actions into ones of re-use was evident. Habits are difficult to break or change so proper education is a necessity and a useful tool available to us.

Recycling

Before introducing the concept of recycling we need to learn about garbage. People have different views about what garbage actually is. Garbage can be leftovers from meals, papers or just about any junk you don't want. It can include cans and bottles, old furniture, junked automobiles and tires. City and public health officials define garbage as "a fraction of the solid wastes that must eventually be treated by the city." [1] Refuse consists of all of the solid wastes of the community, coming from homes, industry, institutions and agriculture, including garbage, rubbish, ashes, dead animals, abandoned cars, demolished wastes and sewage treatment residues. Refuse can be organic (made from things that were once alive) such as: paper, rags, grass clippings, leaves, wood, yard treatments and sludge. Refuse can also be inorganic and can include products like metals, tin cans, stones, glass, bottles and other mineral refuse. Garbage usually smells because the microscopic organisms which break it down release gases. Two of the gases usually released are hydrogen sulfide which smells like rotten eggs and methane which is odorless but can cause explosions.

Presently overcrowding conditions exit at our waste sites and enormous pressure is being exerted to purify our nation's air and water resources. Waste sites include landfills, incinerators, transfer stations and processing plants. Eighty percent of all garbage is buried in landfills. [2] In the United States each of us contributes about 3 1/2 pounds of waste each day, for a total generation of about 1200 pounds of waste per person, per year. [3] Landfills are large holes in the ground with garbage in them. The bottom is sometimes lined with plastic so waste doesn't seep out. The garbage is dumped, packed tightly and covered with dirt. Topsoil is used as a final covering allowing plants to grow, thus preventing erosion. The surface is also treated so rainwater can run off. As garbage decomposes it creates methane and sulfurous gases. As mentioned earlier these gases can cause a rotten egg odor, have serious explosive capacities and can contribute to smog and air pollution. In some cases the gases are pumped out with pipes and used to generate electricity and at times to carbonate soft drinks. When water mixes with the decomposing garbage a liquid called leachate is formed. This liquid is drained off into sewers or storm drains and can mix with our drinking water supplies. Leachate can be toxic. Since landfills are closing daily, the problem of garbage disposal has become a serious one. When left untreated or unrecycled we are faced with dangerous health and pest problems.

Rethinking our current methods of garbage disposal is the first step we need to take in order to begin a successful recycling program. A recent quote in Audbon magazine states, "It boils down not so much to a garbage crisis as a crisis in individual responsibility. The public assumes it's a government problem when it's really an individual problem. We need people to accept responsibility for their own wastes." [3] There are three basic principles "reading, writing and arithmetic," they are "reducing, re-using and recycling."

Reducing means using less. A good example of reducing is to use cloth towels instead of paper ones. Re-using helps us find ways to use materials we would normally throw away such as cardboard, grocery and plastic bags. Recycling is a processing technique used so items can also be used again—crushing glass bottles to make new glass, turning paper back into pulp to make new paper, shredding plastics to make fillings for jackets, and mixing grass cuttings with food scraps for fertilizer are all good examples of this process. The EPA defines recycling as, "collecting, reprocessing, marketing and using materials once considered trash." The dictionary defines it as, "the same material is used over and over again to make the same, or an equivalent product. This costs the amount of virgin materials required for manufacturing." [2] Paper and paper board products comprise more than 1/3 of landfill wastes, with a volume of 35.6%. Next in line by sheer tonnage, are yard wastes at 20.1% of the waste. Next, and about equal in their contribution are metals, food, glass and

plastics, each around 8%. [3] Luckily, these materials are among those most easily recycled.

Recycling provides a way to live in harmony with the limited resources of the world and to protect these resources for the future. It is a way to provide energy from wastes and to renew dwindling resources. Cleaning up the environment is our responsibility and recycling provides us with a means to remove wastes and turn them back into useful products. It is a quick and inexpensive way to deal with garbage, but more importantly it is the first step we can initiate to save our natural resources, conserve energy and save our rainforests.

Recently communities have begun to set up their recycling programs. There are four steps to a successful program: collecting, sorting, reclaiming and reusing. Paper, glass and aluminum top the list of commonly recycled materials. Paper is recycled by using water and chemicals to remove the ink to create pulp. Pulp is cleaned, processed into tiny fibers and made into paper again. Aluminum is ground into small chips, melted down and made into solid bars. As a result, new cans can be made. Glass is broken up into a form of broken glass called cullet. Cullet is then melted down and reused again and again. Slowly but surely we are beginning to become aware of our previous methods of disposal and we are learning to change our behavior.

Composting

What about our food scraps and organic household waste? The next section of this unit deals with just that. In introducing composting as a method of recycling I will explain how compost is nature's way of recycling. Composting is a natural way of replenishing needed nutrients to soil, improving it and creating an environment which plants thrive in. It is also one of our easiest ways to reduce our household garbage volume. Composting turns organic materials into a rich mixture that improves soil and supplies nutrients to plants. Besides building good soil and controlling erosion, composting helps conserve resources and reduces the need to use chemical fertilizers. In the book, *All I Really Need to Know I Learned in Kindergarten* , Robert Fulghum states very simply, "If you make a mess, clean it up." [3] Learning to compost is the first step we can take in cleaning up our mess and reducing our household waste. It is an appealing method of recycling because it is easy to learn. Types of compost, benefits of composting, how to's, materials and uses of compost are covered in this section. Student activities are designed to simulate this concept.

Composting is one of the easiest ways to reduce vegetative waste and turn it into a usable product. It is the biological reduction of organic wastes to humus. [4] In early days when hunting for food was common, man began to compost. Sir Albert Howard, a British government agronomist, studied an organic method of gardening and farming in India from 1905-1934. He devised the Indore method of compost making, in which materials are layered sandwich fashion, then are turned (or are mixed by earthworms) during decomposition. Worms, insects, fungi and bacteria are important decomposers. [4] Today farmers realize that these organic methods restore life to the soil and reduce their use of chemical fertilizers. Plants, animals, insects and people are all linked together in a web of interrelationships with natural resources. Nature is a continuous composting program. Leaves which fall from the trees are composted and become available nutrients to the trees. Birds, animals and insects also contribute their wastes to help grow food. If we look around us at the earth's greenness we are able to see the vast possibilities of nature's composting program. In summary, compost builds good soil texture and structure, helps control erosion, recycles biological wastes, provides and releases plant nutrients, protects against drought, controls pH, supports essential bacteria, feeds helpful earthworms, stops nutrient loss through leaching, acts as a buffer against toxins in the soil, controls weeds, stretches the

growing season and conserves our nation's nonrenewable energy resources. [4]

Decomposition is accomplished by the enzymatic digestion of plant and animal material by soil microorganisms. Processes of oxidation, reduction and hydrolysis are going on simultaneously. Their end products are used by the microorganisms for further breakdown. [4] Bacteria use the products to provide energy for their life processes. This energy is obtained by oxidizing the products. Raw materials have to be of biological origin for decomposition to occur. Then they are broken down to simple forms of proteins and carbohydrates. Carbohydrates break down into simple sugars, organic acids and carbon dioxide. Proteins break down into peptides and amino acids. Through this biological process, the decomposition eventually forms humus. Humus is the finely divided organic matter in soil, derived from microbial decomposition of plant and animal materials. Humus is valued by farmers and gardeners because it provides nutrients essential for plant growth, increases soil water absorption, and improves soil workability. [5]

Because recycling garden and food wastes is a natural process it is important to practice this for maintaining a good environment. Backyard composting is one step we can take towards conserving our energy supplies and regaining control of our food supplies. To begin a compost pile, first you need to choose an area. Once you've chosen the proper area, you can spread the bottom with twigs, corn stalks or wood ships. Next you need a layer of finer materials such as grass clippings or small pieces of kitchen waste. Then a layer of dirt is placed over the garbage and moistened. This "layering" is repeated into the compost pile until the pile is about five feet high. A plastic sheet with small holes in it is sometimes placed on top. The compost pile has to be able to support the activity of the compost organisms. Moisture, temperature, pH and oxygen availability all influence the process. Composting can be done with or without oxygen. Decomposition in nature is mostly aerobic, i.e. done with oxygen. If the compost heap begins to smell there is not enough oxygen. Aerobic composting promotes high temperatures. The decomposition process is slower when the temperature is high, however high temperature is important to destroy weed seeds, insect eggs and harmful organisms. The compost pile also needs to be moist so organisms can thrive. If it is too moist, anaerobic conditions can develop and an unpleasant odor can occur. The pH should be between 6 and 7.5 and can be tested with litmus paper. Acid conditions can be controlled by adding some absorbent materials to the heap. [5]

Once a compost pile has been activated, it is easy to provide a balance of nutrients for it. Kitchen wastes are one of the best sources of nutrients. Some of them to consider are banana skins, citrus rinds, coffee grounds, corn cobs, eggshells, nutshells and tea leaves. These materials decompose more rapidly when chopped or shredded. Other sources of nutrients include: hair and feathers, cut into short pieces (they are high in nitrogen content); leaves which are made up of fibrous organic matter gives good soil building quality; grass clippings, weeds, manure, straw, sawdust, wood ash, limestone, phosphate, rock, cottonseed meal and seaweed are all great nutrients.

Worm Composting

Another method of natural composting is through the use of earthworms. The process of using worms to convert organic waste into black, earthy-smelling, nutrient-rich humus is called vermicomposting. Vermicomposting is a simple process which can be achieved inside one's home by setting up a "worm bin." It is a convenient method used to convert organic wastes into usable end products. Vermicompost contains worm castings as well as partially decomposed bedding and organic waste. Casting is the material deposited

after it has moved through the digestive tract of a worm. [6] Worms need proper temperature, moisture and ventilation conditions to thrive. The first step in setting up a worm bin is to set up a proper container. The container needs to be shallow and of a proper size. Wooden boxes tend to work best and last longest. Once you have a container it is necessary to set up proper bedding for the worms. Beddings which are most desirable are light and fluffy. These conditions are essential for air exchange which helps control odors. Shredded corrugated cardboard makes one of the best beddings for worms. Shredded newspapers or computer paper are also good choices as are animal manure, leaf mold or peat moss. Soil is recommended for the initial bedding because it provides some grit to aid in breaking down food particles within the worm's gizzard. [6]

Redworms are the best worms to use in worm bins. They process large amounts of organic material in their natural habitats of manure, compost piles or decaying leaves. They reproduce quickly and in confinement. The scientific name for redworms is *Eisenia foetida.6* Nightcrawlers are another type of worm that usually do well in gardens but aren't as productive in worm boxes.

A redworm has both sexes which allows each worm to produce both eggs and sperm. There is a swollen region between the head and tail of a worm called the clitellum. The clitellum is an indication that the worm is sexually mature. The worms extend themselves from their burrows to seek other worms to mate with. Through glandular secretions, they find each other and lie with their heads in opposite directions, and their bodies closely joined. Their clitella secrete large quantities of mucus that forms a tube around each worm. Sperm from each move down a groove into receiving pouches of the other worm. The sperm, in a seminal fluid, enters the opening of sperm storage sacs where they are held for some time. After the worms separate, the clitellum secretes another substance containing albumin. This material hardens on the outside to form a cocoon. Here the eggs are fertilized and the baby worms hatch. When the adult worm backs out of the hardened band it deposits eggs from its own body and the stored sperm from its mate. The sperm fertilize the eggs and set up a home for developing worms known as cocoons. [6]

Cocoons are lemon shaped objects about the size of a grain of rice. As baby worms develop, they change color from pearly white to yellow to brown. When ready to hatch the cocoons are a reddish color. The baby worms develop in the cocoons for about three weeks before they are ready to hatch. Each cocoon can contain up to about twenty fertilized eggs but only two to three worms actually emerge from each egg. For a redworm to become sexually mature, proper temperature, moisture and food availability is necessary. Once they are sexually active redworms can breed and lay about two or three cocoons per week for up to a year. Worm survival depends on the availability of food and space in the bin.

Vermicomposting is easy and requires very little upkeep. After the proper environment is provided, burial of garbage is done maybe once or twice a week. Because bedding and garbage is converted to earthworm casting and bedding should be kept fresh. This means changing it and adding to it about every two to three months.

The number of worms needed in the bind depends on the amount of food waste buried daily and the size of the bin. The worm: garbage ratio should be 2:1—one pound of worms to 1/2 pound of garbage. Good food choices for the worms include potato peels, citrus rinds, outer leaves of lettuce or cabbage, celery ends, plate scrapings from carbohydrates, coffee grounds, tea bags, eggshells, and meat waste. You should not use non-biodegradable materials in the bin—plastic bags, bottle caps, rubber bands, aluminum foil and glass would cause problems in the bin. The garbage should be added about twice a week and then covered with bedding. The garbage creates a perfect natural environment for other organisms to feed and reproduce. Worms keep

the conditions aerobic and odor free. They reduce the mass of material to be processed and produce castings. [6]

Once decomposition begins to occur in the worm bin you will begin to see some other creatures present. They play important roles in breaking down organic materials to simpler forms that can be reassembled into other kinds of living things. [6] The food web in a compost pile is varied. (Figure 1). [7] Organic residue is eaten by first level consumers, such as molds and bacteria. Earthworms, beetle mites, sowbugs, enchytralids and flies are also responsible for consuming waste directly. The first level consumers are eaten by second level consumers, such as springtails, mold mites, feather-winged beetles, protozoa and rotifers. Third level consumers are flesh eaters or predators. These include centipedes, rove beetles, ants and predatory mites. [6]

Many of the organisms are microscopic. Enchytracids are usually known as white worms. They are not harmful in the worm bin. Springtails are primitive insects that jump all over the place. They live in almost all types of soil. Isopods or sowbugs look like tiny armadillos. They are vegetation and eat leaf litter so they present no harm to the worms. Centipedes are predators and do kill worms so if they are present get rid of them. Mites are very small with eight legs and a round body. They are not desirable organisms to have in your bin. Although there are a few organisms which can pose a threat to the worm bin, most of the organisms serve as food for each other, clean up each other's debris, convert materials to forms that others can utilize and control each other's population. [6]

When a worm bin is set up in a classroom, students will have the opportunity to participate in various activities. Besides helping to prepare the bin and care for the worms, students will be able to observe and study many aspects of a worm's behavior and biology. Food preferences, mating habits, identifying castings, charting the distribution of cocoons and the rate of growth development are all areas to be studied. These studies also integrate important math skills such as graphing and estimation as students keep records and journals of their observations and findings.

Once the worms have done their job effectively you can begin to use the vermicompost on your house plants and in your garden and almost immediately you will begin to notice healthier plants. Vermicompost is a mixture of worm castings, organic materials and bedding in various stages of decomposition, plus the living earthworms, cocoons and other organisms present and composting continues after a worm casting has been deposited. [6] Humus is an important component achieved in the mixture formed during the breakdown of organic matter. It contains humic acid which is released as plants require it. Humus has been known to stimulate growth and organic gardening encourages carrying out procedures that increase humus content in soil. The vermicompost developed in the worm bin also holds in moisture in soil so its uses are diverse. It can be used in seed beds, in transplanting garden vegetables and as a top—dressing for plant growth in both outdoor gardens and potted plants.

Conclusion

One of the major goals of this unit is to teach children that many items have more than one use and the longer you can reuse these items the better it is for the environment. After understanding the benefits of recycling, composting and vermicomposting, we can learn to do many things to take control over the materials and resources in our lives. The three important concepts to practice are to reduce the amount of

materials you have in your home, to reuse whatever you can and to recycle those items that we were once accustomed to throwing away. Applying these basic principles to our normal, everyday activities help us gain a better understanding and appreciation of the complex balance in nature and is the road towards becoming an environmentally conscious society.

(figure available in print form)

Reprinted with permission from Dindal 1971, *Ecology of Compost* (Figure 1) [7]

Glossary

Biodegradable The property of a substance that permits it to be broken down by microorganisms into simple compounds Composting Mixing food scraps, grass clippings and leaves in an optimal environment for decomposition to form a rich soil condition **Consumer** An organism that feeds on other plants or animals **Decompose** To break down into basic elements; to rot **Garbage** Spoiled or waste food that's been thrown away; any material considered worthless **Humus** Complex, highly stable material formed during breakdown of organic matter **Incinerator** A thermal device in which solid waste is burned for the purpose of volume reduction **Landfill** A site for burial and disposal of solid wastes **Leachate** Liquid that has percolated through solid waste and/or been generated by solid waste decomposition **Resource** Valuable, naturally occuring materials such as wood, minerals, soil and air **Non-recyclable** Items which are made of materials that cannot be recycled **Nonrenewable Resource** A natural resource that is considered finite in amount because of its scarcity or rapid depletion **Organic** Pertaining to or derived from living organisms **Recycle** Any method of reprocessing and reusing products **Renewable Resource** A natural resource derived from an endless source **Vermicomposting** Mixture of partially decomposed organic waste, bedding, worm castings, cocoons, worms, and associated organisms, or, to carry out composting with worms

References

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2. The Earthworks Group. *The Recycler's Handbook: Simple Things You Can Do,* 9, 12. Berkeley: Earthworks Press, 1990.
3. Branson, Gary D. *The Complete Guide To Recycling at Home,* 11, 12, 13, 22. Virginia: Betterway Publications, Inc., 1991.
4. Hunt, Marjorie and Minnich, Jerry. *The Rodale Guide to Composting,* 10, 15, 33. Pennsylvania: Rodale Press, 1979.
5. Bem, Robyn. *Everyone's Guide To Home Composting,* 109. New York: Van Nostrand Reinhold Company, 1978.
6. Appelhof, Mary. *Worms Eat My Garbage,* 5, 19, 22, 28, 43, 59, 66, 68. Kalamazoo: Flower Press, 1982.
7. Dindal, D.L. *Ecology of Compost,* 6-7. Syracuse: SUNY College of Environmental Science and Forestry, 1971.

Lesson Plan

Objective Student will develop an awareness of recyclable items.

Materials paper, pencil

Procedure

1. Review the steps involved in recycling: collecting, sorting, reclaiming and reusing.
2. Make a chart which includes the following information:

Place a check next to each item you threw away this week.

_____ paper bag _____ plastic milk carton
_____ newspaper _____ grass clippings
_____ paper milk carton _____ glass jar
_____ aluminum can _____ gum wrapper
_____ foam food container _____ plastic bag
_____ book _____ napkin
_____ fruit scraps _____ magazines

3. Circle each item you currently reuse and/or recycle.
4. Put a check next to each statement you think is true.

_____ I want to save natural resources. _____ I want to save energy. _____ I am concerned about air/water pollution. _____ I want to save money. _____ I am concerned about the environment. _____ I am not concerned about the environment. _____ Through recycling I can make a difference.

Evaluation:

Discuss the following:

1. Which items did you circle?
2. How could you have re-used some of the items?
3. How would you recycle them?
4. What are some advantages of recycling?
5. What are some of the disadvantages?
6. How can people be educated about changing their living habits to reduce the amount they throw out?
7. Develop a plan to set up a recycling program in school.

Lesson Plan

Objective Students will learn the meaning of organic biodegradable, renewable resource and nonrenewable resource.

Materials

4
glass soil
jars

garbage (misc. solid waste) paper, pencil

crayons

Procedure

1. Discuss what happens to items we throw away.
   - A. Where does it go?
   - B. What is a landfill?
   - C. What items could you buy to save natural resources?
   - D. What items could you buy to reduce solid waste?
   - E. Which items should you totally avoid?
2. Divide typical items thrown away into four categories:
   - A. Organic (potato peels)
   - B. Renewable resource/recyclable (newspaper)
   - C. Nonrenewable resource/recyclable (aluminum can)
   - D. Nonrenewable resource/hard to recycle (plastic milk jug)
3. Label the four jars with one of each of the above category headings.
4. Fill each jar about 1/2 full with soil. Put a small sample of solid waste in each jar. Cover with soil and moisten. Leave the lids off the jars and place each jar away from direct sunlight.
5. Predict and record what happens in each jar.
6. Observe the jars and record any changes which occur over a three week period.
7. Discuss the conditions which are occuring in the jars and compare these to the environmental problems occuring in today's landfills. (ex. smell, leachate, methane gas, bugs, etc.)

Evaluation Students will answer the following questions:

1. Define organic.
2. What does biodegradable mean?
3. Compare what actually happened with your predictions.
4. What happens to organic materials?
5. What happens to renewable materials?
6. What happens to nonrenewable materials?
7. List at least six items you use everyday that could be recycled.

Lesson Plan

Objective Student will demonstrate how paper is recycled.

Materials newspaper, bucket, water, wire whisk, 3 tablespoons corn starch, measuring spoon, piece of screen, rolling pin, sheet of plastic wrap.

Procedure

1. Tear newspapers into very small pieces.
2. Place torn newspaper into a bucket until it is half full.
3. Add water to wet paper pieces.
4. Let stand for several hours.
5. Beat paper mixture with the whisk until creamy.
6. Mix 3 tablespoons of corn starch with 1 cup of water.
7. Add the cornstarch mixture to the pulp and stir thoroughly.
8. Place the piece of screen into and under the pulp and pull it out.
9. Repeat step #8 until screen is covered.
10. Spread sheets of newspaper.
11. Lay the pulp covered screen on the newspaper
12. Cover the screen with a sheet of plastic wrap.
13. Using a rolling pin, press out the excess moisture.
14. Place the pulp covered screen in an upright position so air can circulate through it and it will dry.
15. When the pulp is dry, gently pull the sheet of recycled paper from the screen.

Evaluation Students can list the benefits of recycling paper and can create a list of items made from recycled paper.

Lesson Plan

Objectives Students will learn a low cost, highly effective method of reducing solid waste and improving soil quality through worm composting. Students will observe the earthworm as one of nature's recyclers.

Materials

wooden box about 12" deep (completed ones are available from the New Haven Recycling Office.) 6 pounds of paper for bedding 1 -2 cups of soil eggshells 1 pound redworms (*Eisenia foetida*) 4 pounds food waste per week (1 lb.=1 gal. container)

Procedure:

1. Shred paper into 2 inch strips.

2. Place paper in bucket and moisten it.
3. Put moistened paper into the worm bin and sprinkle in eggshells.
4. Place worms in the box and allow them to burrow down while the box is open.
5. Place approximately 4 pounds of food waste in the box. Some good sources are: apples, banana peels, biscuits, cabbage, cantaloupe, cornmeal, cereal, tea bags, pizza crust, lettuce, grits and coffee grounds.
6. Cover the box with a plastic sheet and close the bin.
7. Bury food waste in the box weekly, rotating the burial location.

Once the worm bin is set up, little maintenance is required. The bedding should be changed after three or four months. In approximately six months, excellent compost will be available.

Many activities using the worms from the worm bin can be completed. Some suggestions follow.

As an introductory activity allow the students to decorate and name the worm bin. Allow creativity to flow—this personalizes the bin for the classroom.

Activity one

Objective Students will observe and study the behavior of the earthworm.

Materials pad, pencil, plastic sheet, ruler, clear large jar, piece of black paper that will fit around the jar, clean sand, soil, decomposed leaves, a piece of plastic covering to cover the jar top, a flashlight, plastic bowl, cookie sheet

Procedure:

1. Place some of the worms from the bin onto the cookie sheet. Examine the worm. With a magnifying glass locate the clitellum, eyes, ears, mouth, head and tail. Describe each.
2. Put some damp soil on the cookie sheet and put a worm on it. Observe and record the behavior of the worm in the damp soil.
3. Measure a worm with the ruler. What happens to the size of the worm as it moves?
4. Put a worm on a piece of paper and place it near your ear. What do you hear? Describe.
5. Fill a clear jar with damp soil to make a layer about 1/2 inch thick. Layer with sand and continue until the jar is full. Add some worms and leaves. Cover the jar with plastic. Put some holes in the plastic to let air in. Cover the jar with a piece of black paper and keep the worms in the dark for seven days. Remove paper and describe what you observe.
6. Next, place some worms in a plastic bowel. Cover the bowel with plastic paper and make holes. Let this sit for one day. Observe what happens. Add some leaves and replace the plastic. Wait one day. Uncover and describe what you see.

Evaluation Discuss all observations and have students answer the following questions:

1. Do worms like damp or dry soil?
2. Do all worms look alike?
3. Are they all the same color?
4. Can they change size?
5. Is it always the same size?
6. How does the age of a worm affect is appearance?

Activity Two

Objective To determine food preferences of the earthworm

Materials Net bags, coffee grounds, cantaloupe

Procedure

1. Fill one of the net bags with coffee grounds and place on one side of the worm box.
2. Fill another bag with cantaloupe and place on the opposite side of the box.
3. Let stand for four days.
4. At the end of four days remove each bag from the bin. Weigh the amount of waste left in each bag. Compare both weights to determine preference.
5. Repeat the procedure using different types of food.
6. Chart the likes and dislikes of the worms.

Student Bibliography

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This book offers many ideas for children to do in the area of recycling.

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Exploring the solid waste problem through demonstrations and experimentation makes this book an excellent guide for children. It provides background information and experiments which motivate children to do something about recycling.

Schwartz, Linda. *The Big Book Of Questions and Answers—Save The Earth.* Lincolnwood: Interaud Publications, Ltd., 1992.

Excellent resource guide for children with questions and answers on topics ranging from understanding the earth to taking action in regards to the environment.

Simon, Seymour. *Discovering What Earthworms Do.* New York: McGraw Hill Book Co., 1969.

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Teacher Bibliography

Appelhof, Mary. *Worm's Eat My Garbage.* Kalamazoo: Flower Press, 1982.

This is the only text written on how to set up and maintain a worm composting system. Great illustrations.

Bem, Robyn. *Everyone's Guide to Home Composting.* New York: Van Nostrand Reinhold Co., 1978.

This comprehensive, easy to follow manual can help one to become an expert at making compost.

Branson, Gary D. *The Complete Guide to Recycling at Home.* White Hall: Betterway Publications, Inc., 1991.

This book addresses the current environmental dilemma and offers suggestions in dealing with the issues.

Earthworks Group. *The Recycler's Handbook: Simple Things You Can Do.* Berkeley: Earthwork's Press, 1990.

The basics of recycling are described in this informative manual.

Goldstein, Jerome. *Recycling: How To Reuse Wastes in Home, Industry and Society.* New York: Schocken Books, 1979.

This is an interesting book which discusses the "garbage addiction" and describes the types of actions people have taken at home, in industries and in society.

Hunt, Marjorie and Minnich, Jerry. *The Rodale Guide To Composting.* Pennsylvania: Rodale Press, 1979.

This book is one of the most complete works on the subject of composting. It is an excellent resource guide.