Curriculum Units by Fellows of the National Initiative
2011 Volume V: Chemistry of Everyday Things

Trash — Seriously!

Curriculum Unit 11.05.08, published September 2011
by Ellen Shackelford

Introduction

Pollution- what a problem! Not my problem! Not my solution! I don't pollute much- I have to ride in a car or bus to get to school, or work, or the store. It's a corporation's problem- not mine. Or is it? What is pollution? Do I contribute to it? I consume products and maybe I just throw them away. It's not always easy to recycle. Do I think about what I consume? Could I use less? Could I reuse some things instead of throwing them away? Do I ever litter? Do I unintentionally litter? Do I pollute? Am I part of the problem? Can I be part of the solution?

Rationale

I teach students in a lower middle class, Title I school. Many of my students don't have a lot of some resources, but, they usually have a lot of consumable products at their disposal. Most of the time they take them for granted, as most of us do. If their pencil happens to roll onto the floor at the end of the day, it stays there. They don't think about it getting thrown away, regardless if it is still useable or not. I find paper, pencils, broken pencils, markers, bottle caps and the like on the floor around the room after the students leave. While they may not consciously litter outside, they are littering inside. In addition, they don't think about what they throw into the trash, plastic water bottles, often still filled with water, and paper. My students are not conscious about how they dispose of their resources or what happens to them. I doubt they know where the landfill is or how big it has been growing thanks to trash that is thrown out. Most of the students might think a little about recycling since our school had a program to recycle the plastic milk bottles. But all they had to do was put their bottle in a special container before leaving the cafeteria. It hardly required any thought. They don't think about recycling their water bottles or paper. They don't think.

One of the fifth grade science units is Ecosystems. In the unit, the students set up a model ecosystem, (in a two liter plastic soda bottle). Then, they pollute the ecosystems with three different pollutants, salt, acid, and fertilizer. While the students see the pollutant effect of these elements, they don't relate to the pollutants very well because they don't see themselves as the polluters. They don't really see the link between the salt put down on the roads to melt ice and salt in the water supply. Also, they don't personally use fertilizer, so it's hard to relate to that pollution. They can link the acid to pollution from automobile engines, but this is the closest link they have to these substances- and they really don't have any control over that.

I want my students to feel their personal connection with pollution and the part they play in it. I want them to see themselves, their friends, and families, as potential polluters by examining everyday products they do use and what they do with them when they dispose of them. I want them to want to change the ways they act as a direct result of this connection. I hope that they will spearhead a recycling program in the school and take responsibility for it.

Strategies

I will use a number of hands-on investigations and activities to guide my fifth grade students through the process of analyzing their actions, and the resulting implications on organisms and the environment, with three products they use daily. They will utilize all of the levels of Bloom's taxonomy. First, they will identify and define pollution at a personal level; then they will identify the chemical components and properties of three common products. With this in mind, they will analyze the pollution caused by the disposal of the products. Then, they will compare and analyze possible solutions to the pollution problems with the products, such as recycling, or reduction of use. And finally, they will evaluate the problems of pollution with these products and potential solutions to them, and design a plan to change their behavior and/or someone else's behavior to help solve some of the problems.

Pollution

(Student Activity #1, Appendix D)

Britannica encyclopedia defines pollution as follows: "The addition of any substance (solid, liquid, or gas) or any form of energy, (such as heat, sound, or radioactivity), to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form. [1] This definition covers a wide range of activities that most individuals do every day, that we usually don't consider to be pollution. Our trash is pollution. If I throw out my used paper and deposit it into the trash receptacle, a trash company transports it to the landfill. I am certainly adding substance to the environment quicker than it can be decomposed. As to whether it can be stored in a harmless form- that is certainly a matter of opinion. However, considering the out of control growth of landfills, I doubt anyone could accurately call it "harmless storage". Of course random discarding (littering) of items we have no further use for, would also be considered pollution, since we are, once again, adding items to the environment faster than it can be decomposed and not controlling their storage in a harmless form either. It has been estimated by the American Forest and Paper Association that 20.3 million tons of paper were sent to landfills in the United States in 2010. [1] As for plastic water bottles, only 24% are currently being recycled, leaving 76% as either going to the landfill or other waste. [2] Only about 2% of all the plastic bags make it to recycling, leaving a whopping 98% in the landfill or the environment. [3] So, it would appear as if a lot of us pollute.

What are Plastic Water Bottles and Bags made of?

(Student Activities #2 and #3, Appendix D)

Plastics have unique characteristics that make them useful and helpful in everyday life. They are light-weight, flexible and durable. They may be molded into various forms, bottles, bags, containers, cell phone cases, even clothing. Plastics are polymers. Polymers, (poly means many), are composed of monomers, (mono means one), single molecules that combine chemically into long chains of many monomers. (Molecules are particular combinations of atoms that create matter, like H_2O, which is the molecule for water from 2 atoms of hydrogen and 1 atom of oxygen.) How are polymers created? The monomers are combined with heat and a catalyst (helper) chemical and the result is a polymer; there are many different polymers though, depending on the monomers. (You don't recognize the monomers in the polymers!) The bonds between the molecules have changed and reorganized into strong chains, which makes them so durable. There are polymers that occur naturally, such as cellulose and cotton in plants, and even DNA, and some scientists are starting to try using the plant polymers in plastics. Why would this be good? They would probably be able to decompose, and, they are renewable resources. The monomers used to create most polymers come from petroleum products. [4] Petroleum products are nonrenewable resources. Even though plastics currently use less than 4% of the world's oil, the consumption of oil continues to increase for gasoline, and the demand for plastics continues to rise as well. [4] Which is a better use for the oil?

No one would consider drinking a petroleum product, yet after they are transformed into plastic, by altering the chemical bonds, we use the plastic to hold liquids that we drink. Also, additional chemicals, plasticizers and colorants are added to give the plastics we love to use additional attributes such as flexibility, texture, color, and resistance to melting. Some plastics, called thermosets, stay rigid and don't melt when they are heated. Thermosets are created by forming covalent cross-linked bonds in the polymer chain. (A covalent bond exists between atoms when they share an electron.) These covalent bonds are naturally going to be strong, and, super-hard to break. Thermoset plastics are products like CD, TV, and cell phone cases. Other plastics, called elastomers, don't have as many bonds as the thermosets, but also are resistant to reshaping through heat. These are used primarily for tires. The majority of plastics manufactured are thermoplastics. [5]

Water bottles are made from Polyethylene terephthalate (PET or PETE) which is an example of a thermoplastic created from two monomers: terephthalic acid and ethylene glycol, both of which come from crude oil. They are represented chemically as $C_8H_6O_4$, (terephthalic acid) + $C_2H_6O_2$, (ethylene glycol), which gives you the polyethylene teraphthate, $(C_{10}H_8O_4)_n$ + H_2O,(water). [7] The $_n$, signifies that it repeats n number of times. The atoms and bonds are rearranged, and it keeps repeating. It's still the same Carbon and Hydrogen elements that were in the monomers. It's amazing what a little rearranging can do! So you see, the monomer that comes from oil is really still there. About 30% of manufactured PET is used for water and soda bottles and the rest is used to make polyester thread, for clothing and carpets. [5]

The caps on the water bottles come from a different plastic, polypropylene, a more rigid thermoplastic. Polypropylene comes from the monomer, propylene, represented by, C_3H_6. It becomes the polymer, polypropylene, represented as: $(C_3H_6)_n$, where the n stands for n number of times the monomer is repeated in the polymer. [7]

We have to wonder if these plastics are safe to use for drinking bottles since they come from crude oil, as well as additional chemicals and pigments added to enhance the characteristics of the plastics. For the most part, these plastics have been considered safe to use. One plastic, Polycarbonate, was found to leach a hormone-like chemical, bisphenol A, into the liquids when the liquid or the bottle was heated. These bottles have been banned in many states, including Delaware. The Food and Drug Administration has tested the PET bottles over time and concluded and reported that they are safe and don't leach any harmful chemicals. In fact, rumors circulated on the internet warning people not to use PET bottles that were subjected to heat, such as those left in a hot car are untrue. This makes sense since the chemicals in the plastic need about 700 degrees centigrade to melt, and don't contain the problem chemical in polycarbonate bottles. [6] It has to make you a little wary, since the polycarbonate bottles were originally thought to be safe!

Plastic bags come from another thermoplastic, Low-density Polyethylene, (LDPE). It is a very flexible plastic, used primarily for bags. It is also made from the monomer ethylene, C_2H_4, which also comes from crude oil. [7] This monomer becomes the polymer, LDPE, as, $(CH_2H_4)_n$ where, again, the n stands for n number of times the monomer is repeated in the polymer. [7]

Where does paper come from?

(Student Activity #4, Appendix D)

Most paper comes from the cellulose in trees; some paper comes from linen, cotton or other plants. Cellulose is a natural polymer. It consists of fibers glued together with another natural polymer, called lignin. The monomer in the polymer cellulose is: aldohexose D-glucose, which is represented by: $C_6H_{12}O_6$ and changes into the polymer cellulose which is represented by: $(C_6H_{10}O_5)_n$,plus water, H_2O. Again, the $_n$ stands for the repeating of the monomer in the polymer. In fact, the chain of the polymer, cellulose, can consist of several hundred to over 10,000 repeating units. Trees also have another polymer, lignin, which holds the cellulose together and has been compared to an early thermoplastic polymer, Bakelite. The lignin is chemically washed away from the cellulose to make paper. [8]

To make high quality paper, the cellulose from both hard and soft wood trees is used. Hard wood trees have longer fibers and the soft wood trees have shorter fibers. In the processing of paper, the wood is ground into pulp, the lignin is removed by washing and chemicals, the water is pressed out and the paper is dried. Paper is often bleached and filled with clay and calcium carbonate. Then high quality paper is usually coated with paint-like substances to give color and sheen. [8] Paper demand has increased 400% in the last 40 years and 30% in the last 6 years. It is projected to increase even more. The EPA has disclosed that paper mills are some of the worst polluters of air, water, and land. They release toxic chemicals into air and land, including: toluene, methanol, chlorine dioxide, hydrochloric acid, and formaldehyde. [8] Most of the trees used for paper come from tree farms and which are regularly replanted, and thus renewable. However, it was noted that with the growing demand for paper, the soft wood trees cut for paper have begun to outnumber the growth of new trees. [9]

Landfills

(Student Activities #5 and #6, Appendix D)

Where does trash go? Landfills are places that store trash. Landfills charge trash companies or individuals to store their trash. Originally landfills were merely huge ditches where the trash was piled. Modern landfills are designed to keep the trash from affecting the soil or aquifers from the trash stored above it by using plastic or clay liners to separate the trash from the ground. As the items in the landfill decompose, mainly food, or plant material, they produce both heat and liquid. This liquid then seeps through the rest of the trash. If the other trash has toxic chemicals, even paint, pesticides, fertilizers, or automobile oil, etc., the liquid carries this with it. The decomposition also produces CO_2, which is water soluble and increases the acidity of the liquid. Then the liquid becomes more corrosive and so can add more toxins to it as it corrodes materials in its path. This problem, identified in the 1970's and 1980's as contamination called leachate, was reaching groundwater. However, the EPA estimated that more than 75% of the landfills in the United States, now, had escaping leachate. [10] In addition, most engineers admit that the liners installed today, will not last forever. The trash is divided into cells to separate a large landfill. The trash in the cells is regularly compacted and soil is bull dozed over it to bury it. By burying it and covering it with a cap to separate it from precipitation, the decomposition is minimized, since it is separated from water and oxygen.

In addition to the leachate, methane gas is produced from the decomposition, and modern landfills are required to monitor this since it is very flammable. The landfills collect the gas and either burn it or use it for heat. [4] Some scientists and environmentalists are worried about the collection of the methane gas. They believe that the methane gas has pollutants and carcinogens with it- thus making it extremely dangerous. However, landfills are actually given credit for the collection of the methane gas as a renewable energy source. No doubt, we should not be looking to landfills for renewable energy sources that are dangerous to our planet. [11] Landfills can get very large before they are considered full and closed. After closing, some landfills have become parks, with benches and playgrounds sitting high atop the buried garbage. Communities must monitor the ground below for additional methane gas as well as undue settling. Certain activities must be avoided to avoid breaking the ground into the area of trash.

Some landfills have burned the trash over the years. Regulations and laws have increasingly regulated this as well as the emissions from burning the trash. Some areas have been able to recapture some energy, (usually by heating water into steam) as usable energy. This is more common in Europe than the United States, where land is scarce. However, the decrease in landfills, there were 8,000 in the United States in 1988 and only 1,654 reported in 2005, may necessitate this more and more. [12] Why the decrease? Besides regulations and the burgeoning amount of trash, as areas where people live grow, resistance to landfills grows. No one wants a landfill next to their neighborhood.

What sort of trash is in a landfill? Almost everything disposed of used to be in the landfills; however, regulations have banned things such as biomedical wastes, and other hazardous products such as oil and paint. Although, that doesn't mean it isn't there. We all know people who slip these substances into their trash, either because of convenience or ignorance. Most of the volume of the landfills though, currently, is paper. The Garbage Project, in 1991, exhumed eleven U.S. landfills and found 50% of their volume was paper. [4] It has been estimated by the American Forest and Paper Association that for every ton of paper that is recycled, 3.3 cubic yards of landfill is saved. [2]

Plastic bags in the environment

(Student Activity #7, Appendix D)

Another problem with plastic bags is when they end up in the environment, particularly the oceans or waterways. One problem with plastic bags is that they are light and aerodynamic. Even when one is trying to dispose of them correctly, perhaps even recycle them, they blow away. You can be using one on the beach, and it blows away. San Francisco, California was spending over $ 8.5 million annually to clean up plastic bag litter. [11] Washington, D.C. finally enacted a $ 0.05 per bag levy to reduce the littering problem and help clean up the Anacostia River from bag and other litter. [12] In fact many states and cities have recently banned the bags, including: Bethal, Alaska; Edmonds, Washington; Brownsville, Texas; Kauai, and Maui Counties in Hawaii; American Samoa; San Francisco, Fairfax, and Palo Alto, California; and Westport, Connecticut. [13] Philadelphia, Pennsylvania has noted problems with plastic bags clogging old water systems, and Virginia has experienced problems with plastic bags clogging cotton harvesting and cotton gin machines. [12] The problems these bags create in the oceans are tragic to animals. Turtles that feed on jellyfish mistake the bags for food and eat them. This of course causes problems for the animals, usually resulting in death. Ships at sea used to regularly dump their wastes into the ocean. Since 1978, the International Convention for the Prevention of Pollution from Ships banned dumping of most wastes, including plastic bags. [4] Residents of the Outer Banks, a coastal beach area in North Carolina, experienced enough of a problem in the ocean from bag litter to ban the use of them. [10] Another problem discovered in the Pacific Ocean, perhaps from the previous ship dumping along with bag littering, is a huge section of plastic trash in the Pacific Ocean between California and Hawaii, called the Pacific Garbage Patch. It is estimated to be at least 100 feet deep and five million square miles in area. Basically, plastic bags, and other plastic material have been riding the ocean currents to this spot. Scientists have found birds, turtles, whales, as well as small sea creatures that have ingested the plastic. In addition to the obvious problem for wildlife, scientists also believe that the plastic absorbs toxic chemicals, such as PCB's and pesticides in the ocean. The implications for this huge disaster are unknown. [13]

Reducing the use of PET Water Bottles

(Student Activity #8, Appendix D)

In order to decrease the problem of PET bottle disposal, a reduction would be beneficial. The water bottle industry has created an idea that the water in their bottles is better than the water from the tap. This is called manufactured demand. While there are some places where this is true, in most places in the United States, the tap water is both safe and tasty. The National Resources Defense Council, (NRDC), conducted a four year study of bottled water and U.S. tap water. They found that the EPA regularly tests and reports testing of tap water, whereas the bottled water industry is only rarely tested by the FDA with much lower standards for contaminants. [14] The EPA, in fact, has no regulations in respect to the temperature of stored bottled water. So, a group of scientists at the University of Texas conducted a study of tap water and bottled water stored at room temperature. They found that the bacteria count increased dramatically when stored at room temperature, (23 degrees C), after 8 hours of time, increasing up to 48 hours, in bottled water, after one drink from the bottle. There was no change in tap water under similar conditions. [15] The NRDC also found bacterial contaminants in their four year limited testing of bottled water. In addition, they found that a significant number of bottled water companies are getting their water straight from the tap, not natural springs or glaciers. [13]

Recycling PET plastics and Polyethylene Plastic Bags

(Student Activity #9, Appendix D)

Recycling success is dependent upon three factors, whether the product can be recycled into useful new products, if there is an economic market for the products, if it is economically feasible, and if people are willing to recycle them. As noted before, about 24 % of PET bottles are currently recycled. [3] Only 2 % of plastic bags are recycled in the United States. [4] One of the problems with plastic bag recycling is that each bag contains very little plastic, so the recycling value for each bag is very low. It is only with a large quantity that economic recovery is realized. In fact, most plastic bag recycling for the west coast of the United States goes to China. This actually works out pretty well, since the empty ships returning to China from delivering exports to the United States take the bags back to China to recycle them, mostly into fibers which China needs. Actually, plastic bags can be more of a problem than a benefit to many recycling centers. In San Francisco, the bags kept tangling the machines used to process recycled plastic, requiring nearly $ 700,000 annually. [10] Most recycling pickups won't take the plastic bags with the other recycled material. In Delaware, recycling is done in single stream pickups or drop off containers, (recycled materials don't need to be sorted); however, the bags are excluded from the pickups or collection points. Delaware, New York City, and Rhode Island, among others, have laws, though, requiring stores that distribute plastic bags to provide recycling receptacles. [10] Due largely to the low percentage of recycled bags and the low amount of plastic from each bag, the options for products from recycled bags is largely limited to fibers for clothing or carpet. [10] There are few incentives for companies to expand the recycled products, since the recycling rate is so low.

Plastic, PET, bottles are recycled at a rate better than any other plastic material. [6] Due to the strong cross-linking bonds in the plastic polymers, it is difficult for the plastic in the bottle to decompose. While most recycling centers use density or various photo imaging processes to separate the bottles from other plastics, there are errors and plants have to rely on a relatively large labor costs to manually finish the sorting process. In order to recycle the bottles, they need to be separated from other types of plastic, because the different plastics don't mix together, (like oil and water). Bottles without colors are generally preferred, since the color can't be removed from the original product in the recycling. [6] The bottles are melted, washed, and cut into small pellets of material that can be processed into various products, such as: scouring pads, auto parts, tires, paint brushes, landfill liners, paints, fabrics, and synthetic wood products. [16] In some areas that are offering single stream recycling, such as Delaware, the comingling of the bottles with other materials often renders the bottles unsuitable for some recycling, such as into new water bottles. In fact, recyclers would like to add old recycled PET bottles into new plastic bottles. This would reduce the amount of plastic required for the new bottle, but they have not been able to do that, yet. [10]

Recycling, Reusing, or Disposing of Paper Products

(Student Activities #10 and #11, Appendix D)

According to the American Forest and Paper Association, 63.5% of paper manufactured in the United States was recycled in 2010. That amounts to about 51.5 million tons of paper! However it means that 20.3 million tons were still sent to the landfill, where it will probably sit for a long time. As noted before, it is estimated that for every ton of paper recycled, 3.3 cubic yards of landfill are saved. [2] In addition, 165 gallons of gas is saved for every ton of paper that is recycled. [6] And, recycled paper requires 50% less water to be reprocessed than original paper. [18] So, not only are you saving trees, you are saving nonrenewable gasoline, and water by recycling paper. Paper can be recycled into a number of different products. Some recycled paper is combined with the tree pulp to make new paper. It can also be used to make over 5,000 products, including: masking tape, tissues, greeting cards, egg cartons, coffee filters, and toilet paper. [19]

Final Steps

(Student Activity #12, Appendix D)

Students will prepare a persuasive essay. The essay will be addressed to someone or a group who can make a difference with regard to plastic water bottles, plastic bags, or paper disposal. This could involve a recycling project or suggested legislation. The essay must reflect the information that the student has obtained from the unit. I will do my best to encourage the students to start a recycling program at my school that they can manage.

Appendix A: Endnotes

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Appendix B: Students Sources and Classroom Resources

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bottled water.

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Appendix C: Implementing District Standards

DE Science #1: Nature and Application of Science and Technology

Generate focused questions and informed predictions about the natural world.

Use mathematics, reading, writing, and technology when conducting scientific inquiries.

DE Science #2: Materials and Their Properties

Materials exist throughout our physical world. The structures of materials influence their physical properties, chemical reactivity and use.

Strand 1: Properties and Structure of Materials

Observable physical properties can be used to classify materials.

Many materials can be recycled and used again (sometimes in different forms).

DE Science #6: Life Processes

The natural world is defined by organisms and life processes which conform to principles regarding conservation and transformation of matter and energy. Living organisms use matter and energy to build their structures and conduct their life processes, have mechanisms and behaviors to regulate their internal environments and to respond to changes in their surroundings. Knowledge about life processes can be applied to improving human health and well being.

Life Processes and Technology Applications

Short term and long term studies are used to determine the effects of environmental changes (natural and man-made) on the health of the organisms within that environment.

DE Science # 8: Ecology

Organisms are linked to one another in an ecosystem by the flow of energy and the cycling of materials. Humans are an integral part of the natural system and human activities can alter the stability of ecosystems.

Interactions within the Environment

Human Impact

Human activities may cause pollution of air, water and soil.

Different technologies are used to access resources to meet human wants and needs. In many cases the environment is affected and resources become limited.

DE ELA #1: Students will use written and oral English appropriate for various purposes and audiences.

DE Math #3 (5–8) – Geometric Reasoning: Find the volume of an object

This unit addresses all of the above standards in Science, English Language Arts, and Math. The students will examine the physical properties of polymers and paper (Sc. #2). They will analyze the effects of plastics and paper within the environment on other organisms (Sc. #6). Students will analyze and evaluate the impact of plastics and paper on the environment (Sc. #8). They will use mathematics to find the volume of the room to visualize the volume of paper (M #3). And finally, they will evaluate their action by means of a persuasive paper (ELA #1).

Appendix D: Student Lesson Details

Appendix D: Student Activities

Student Activity 1

Objective: Students will identify pollution.

Essential Question: What is pollution? What is not pollution?

Procedure:

1. Teacher will show the students a short powerpoint of pictures depicting pollution. Preferably, the pictures will come from surrounding area.

2. Students will work in cooperative groups of 3-4, and brainstorm their ideas to define pollution.

3. Class will discuss and brainstorm together the ideas to define pollution.

Closure: Class will create a definition for pollution.

Student Activity 2

Objective: Students will model a polymer.

Procedure:

1. Students will line up and link their arms to model how a polymer is linked.

2. Another way the students can model the polymers is to link paper clips.

3. Other polymer examples can be collected and displayed for observation, such as gum,

gummy worms, rubber bands, synthetic fabric, nylon stockings, pencil erasers, CD cases, and balloons.

Student Activity 3

Objective: Students will compare the unique chemical reaction of a polymer with a simple solution.

Essential Question: What is different between a polymer and a powdered drink mix?

Procedure:

Students will make a powdered drink mix in a glass, such as Kool-aid.

1. Students will mix 1 teaspoon Borax (sodium tetraborate) in 8 oz. of water. (Distilled water works slightly better than tap water.)

2. Students mix equal amounts of glue and water, mixing thoroughly, 8 oz. bottle with 8 oz. of water works well. (You can add a couple drops of food coloring if you want.)

3. Now slowly add the Borax solution to the glue solution, and knead with your hands, or put into Ziploc bags to mix.

4. Students will observe the characteristics of the silly putty ball.

5. Silly putty ball may be stored in a sealed Ziploc bag to retain its properties.

6. Students will compare the difference between the silly putty ball and the glue, water, and borax with the powdered drink mix and the water and powder.

7. Can the silly putty ball return to the original ingredients? Can the powdered drink return to the original ingredients?

8. The glue already has a vinyl polymer in it, but the water helps the vinyl molecule to untangle. Once the Borax is added, it creates the cross-linking of the molecules.

9. Other polymer examples can be collected, such as gum, gummy worms, rubber bands, synthetic fabric, nylon stockings, pencil erasers, CD cases, and balloons.

Closure: Students will see that the ingredients of polymers don't look or act like the resulting polymer. Polymers have rather unique characteristics.

Student Activity 4

Objective: Students will compare a model landfill with a liner, to a model landfill without a liner, note the differences in the water below and analyze the potential differences in an environment.

Procedure:

1. Students will use two, 2-liter soda bottles to construct model landfills. The teacher will cut the bottles into 2 pieces. The bottom piece should be about 5 inches high. The upper piece should be about 6 inches high. The upper piece will be inverted into the bottom piece. (See diagram A.) The first landfill model will have a piece of plastic covering the opening of the bottle, fastened with a rubber band. The other bottle will have a small piece of screen, fastened with a rubber band. On top of the plastic or screen a small layer of gravel should be added. On top of the gravel a layer of soil, about 3 inches should be added.

2. About 1 inch of water should be added to the bottom layer, representing ground water.

3. Next the students should simulate adding things to the landfill. They should add: "oil" in solution with water (red food coloring, water, and vegetable oil can be used).

4. Students will observe the water in the bottom, noticing any changes.

5. Questions:

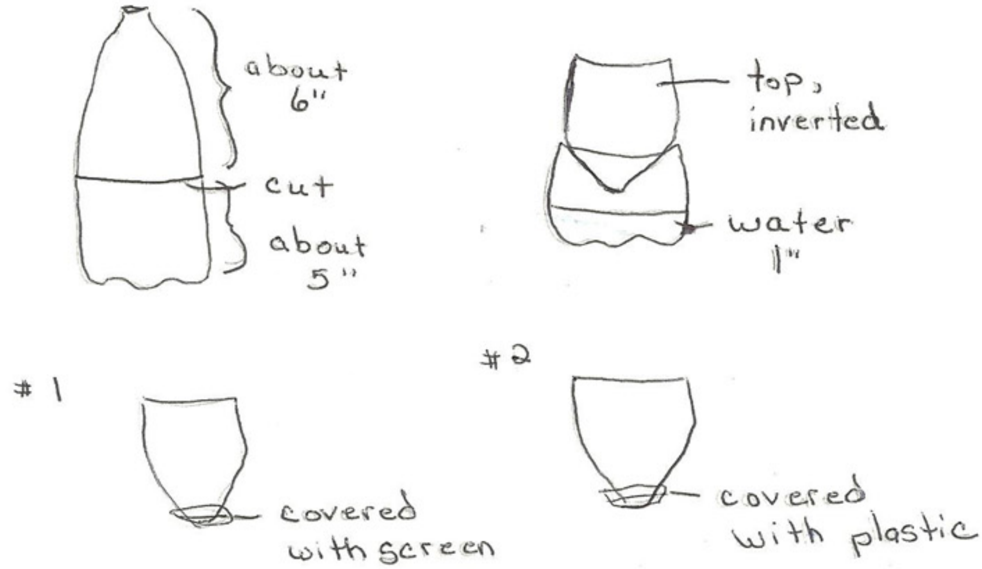
What did you notice in the water of the landfill with the liner?

What did you notice in the water of the landfill without the liner? Why did this occur?

What do you think would happen in real life? Why? What do you think could happen to the environment? What might be some of the contaminants that could be dumped into a landfill? Which model would be best for the environment? Why?

Closure: Students will note that any contaminants added to the landfill without a plastic liner would eventually leach down into the ground and groundwater below it.

Diagram A:


about 6"
cut
about 5"
top, inverted
water 1"
1
covered with screen
2
covered with plastic

Student Activity 5

Objective: Students will determine how well various substances decompose.

Procedure:

1. Students will set a deep dishpan or plastic container to create a model compost pile. It is best if the container has small drain holes in the bottom, so that excess water can drain out. If there are holes, the container should be placed on the grass or in another container, to catch the drainage.

2. Students will layer a thin layer of brown matter, such as dead leaves, newspaper, straw, or sawdust.

3. Students will then create a thin layer of green matter, such as grass clippings, or other green plant matter. (You can add food matter, but you should only do this if it will be stored outside and can be protected from animals.)

4. Students will place various products in both bins, including paper, a piece of a regular plastic bag, a piece of a biodegradable plastic bag, a piece of a plastic water bottle, as well as cardboard. These items should be in very small pieces, since the compost pile is small, about the size of a deck of cards.

5. Top it off with a thin layer of manure or topsoil. This will add the microorganisms that will speed the decomposition process.

6. Sprinkle with water.

7. Keep outside, at least during the day.

8. Students should record the matter they add to the pile.

9. Students should periodically check the pile to check the temperature and see if there are any changes. (The temperature should rise as the materials decompose.)

Closure: Students will note that some things decompose, or break down, in the compost pile, but other things don't change.

Student Activity 6

Objective: Students will calculate the number of days it would take to fill up the room with discarded paper.

Essential question: How much paper would we be sending to the landfill?

Procedure:

1. Teacher will secretly collect the paper discarded by the students in the classroom. He or she could also include a daily newspaper to speed up the simulation.

2. When the teacher believes there is enough paper to fill a rectangular cardboard box, he or she will stop and tell the children what he or she has done.

3. The class will calculate the volume of the classroom from measurement and the formula for volume. Then the class will calculate the volume of the box. By dividing the classroom volume by the box volume, they will determine how many boxes it would take to fill up the room with paper. If the box took 2 weeks and the number of boxes required to fill the room is 100, then the class can reasonably conclude that it would take about 100 multiplied by 2 or about 200 weeks to totally fill the room with paper. (A further

conclusion could be determined to estimate the amount of days to fill up the room if all the paper in the school were added. Divide the total number of boxes by the number of rooms in the school, say 100 boxes needed to fill the room, divided by the 20 homerooms in the school, which would equal 5 multiplied by the 2 weeks and it would take only 10 weeks for the whole school to fill up the room with discarded paper!

Closure: We throw out a lot of paper and it takes up a lot of room.

Student Activity 7

Objective: Students will observe and test plastic bags in the air and water.

Essential Question: How do plastic bags create problems in the environment?

Procedure:

1. Students will take plastic bags outside.

2. Students will let go of the bags and see what happens to them.

3. If there is a wetland available, students can release bags into the water and observe.

4. Students should make sure they retrieve the bags after the observations.

5. Class will discuss the observations and make conclusions of the effect of plastic bags in the environment.

6. Teacher will show internet pictures of the Pacific Garbage Patch.

Closure: Students will see that plastic bags are aerodynamic in the environment and float in the water. They will make conclusions regarding the implications of this in the environment.

Student Activity 8

Objective: Students will conduct a taste testing of bottled and tap water among the school students and make conclusions based on the test.

Essential Question: Which water tastes better, bottled water, filtered tap water, or regular tap water?

Procedure:

1. Students will conduct a blind taste test of 2 different kinds of bottled water, tap water filtered with a simple pitcher filter, such as Brita, and unfiltered tap water. They will use paper cups that are not identified, except as A, B, C, and D.

2. Students will conduct the testing in other classrooms in the school.

3. Students will compile the data and discuss it. Students will create a poster bar graph.

4. Students will publish the graph for the school.

Closure: Students will make conclusions based on a taste testing between bottled and tap water.

Student Activity 9

Objective: Students will see how paper is made.

Essential Question: How is paper made?

Procedure:

1. Students will either watch the video online at the Glatfelter, Inc. website: http://www.glatfelter.com/learning/tour_pop_up.aspx, or by obtaining a CD from Glatfelter, or take a field trip to a paper mill, if that is available. Each source shows the steps in making paper.

Closure: Students will discuss the paper making process.

Student Activity 10

Objective: Students will observe the effects of melting different plastics together.

Essential Question: What happens when plastics are melted together?

Procedure:

1. Teacher will ask the students to bring in a variety of plastics. They should have various recycling codes, including 1, 2, 4, 5, and 6.

2. Teacher will cut samples from 2 plastics for each demonstration, heat them in an aluminum foil pan on a hotplate to about 300ºF. (Be sure you are in a well-ventilated area!)

3. Teacher will use a glass or metal rod to stir the melting plastic.

4. Students will observe the melting plastic and see how they mix.

Closure: Students will see that the plastics resist mixing together.

Student Activity 11

Objective: Students will recycle paper and compare recycled paper to paper that has not been recycled.

Essential Question: How is paper recycled? How does recycled paper compare with original paper?

Procedure:

1. Students will shred newspaper.

2. Students will mix up the shredded newspaper with water, using a mixer.

3. Students will pour the mixture onto a screen.

4. Students will allow the screen to dry overnight or use a blow dryer to speed the process.

5. Students will compare the recycled paper they created, along with other samples, (i.e. napkins, paper towels) to paper that has not recycled, using a hand lens, observing the fibers in the different examples.

6. Do you notice a difference between the two examples? What do you notice?

Closure: Students will see that paper can be recycled, but they will notice the difference between the recycled products and the original products.

Student Activity 12

Objective: Students will compose a persuasive essay letter to someone who could help reduce pollution or production of plastic or paper products. In addition, students will initiate a recycling project in the school or community.