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The Risk-Benefit Factor Challenging Our Environment

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As we direct our senses globally we cannot help but see a changing and life-destroying society. There are so many factors including technology which contribute to the degradation of the environment. Coupled with this are varying degrees of risks to our health and the health of other species. The key questions we need to ask ourselves are whether the risks of damage from each hazard outweigh the short and long term benefits and how we can safely reduce the hazards and minimize the risks.

This curriculum unit is developed for seventh grade students over a period. It is designed to encourage critical thinking and for students to involved in the decision-making process resulting in success and good health for all life. This trend of thought will heighten their awareness of the risks and benefits involved in developing technology and therefore students must be guided to make informed decisions. Emphasis would be placed on the interdependence of all organisms and the many ways they can protect and improve the environment.

After studying this unit, it is my hope that teachers and students will become pro-active in identifying the risks and benefits involved in controversial issues having learned how things are interconnected and the relationship between the environment and human health. To adopt this approach and bring about a change in our attitudes and manner of thinking, *mankind* will survive the harmful effects of the environment.

Types of hazards:

Physical noise, volcanic eruptions, or ionizing radiation

Chemical:

a) harmful substances in the air, water, food, or sod.
b) carcinogens refer to chemicals, ionizing radiation that can cause or promote the growth of a malignant tumor or cancer.
c) mutagens are chemicals, ionizing radiation that can cause mutations.

Risk-analysis involves identifying hazards, evaluating the nature and severity of risks, using that information

to determine options and make decisions about reducing and eliminating risks.

Risk-benefit analysis involves estimating the short and long term societal benefits and risks involved and then dividing the benefits by the risks to find a desirable quotient. In a risk-benefit analysis, the following factors can be considered:

a) How important is the substance?
b) How large is the segment of the population that would be expected to benefit?
c) Is it possible that the benefits outweigh the risks?

Risk-benefit Factor

Objectives Students will have opportunities to:

1. Think critically on key issues and make informed decisions.
2. Identify the risks and benefits involved in controversial issues.
3. Describe and discuss alternate methods of controlling pests.

The following passage is read to the class. Students will be permitted to record important points mentioned in the passage to be discussed orally in small groups.

Living organisms interact with one another and their surroundings for survival. Their existence can deteriorate when lethal materials interfere and disrupt their efforts to survive. When the atmosphere and the oceans become polluted with toxic chemicals, the chain of reactions initiated can lead to death of these living organisms. The release of toxic chemicals in the atmosphere returns to the earth in the form of rain or wind and later enters the crops in farmlands. This crop is soon harvested and later enters into the bones of human beings leading to death. Conversely, these chemicals can seep through the soil, combine chemically with air and sunlight to form new chemicals which could kill the existing vegetation. The application of these chemicals is therefore non-selective and has the power to kill every insect—the “pest” and “non-pest”. Man’s total environment will become contaninated—the streams, insects, birds, plants, humans, and soil. So therefore it is not just the intended target that becomes affected. In the long run these deadly substances that penetrate the tissues of animals will soon harm the germ cells and alter the very material of heredity. Some chemicals can be mutagenic or may contain metabolic derivaties that are mutagenic. Because effects of induced mutations are generally detrimental, it is important to identify potential mutagens and to assess their possible impact on future human health.

Students will work cooperatively in small groups of four and discuss the following questions based on the above passage.

1. What choice shall be made? Give reasons for your response.
2. Should we risk our future lives over the choice of an insect spray? Why or Why not?
3. Can we really control unwanted species by a method of “insect spray” without contaminating the environment and upsetting the delicate balance of the ecosystem? Explain.
4. Imagine you are the owner of an apple orchard. Do you believe that the chemical pesticide you release into the environment should be assumed to be guilty of cansing harm until proven otherwise? Explain and give your opinion on this matter including any effects this principle would have on your life and lifestyle.

To assess the risk involved in spraying the crops with insecticide, one must regard the concept that the probability to harm from exposure to a toxic substance is a function of two variables: a) the exposure or potency b) the dose of the substance. It is very crucial to understand the degree or duration of exposure to certain chemicals in order to evaluate the canse of health problems. Exposure to a toxic chemical may be acute or chronic For example, taking one aspirin tablet every four hours for one day will be less toxic and harmful than taking fifty aspirin tablets at one time. Again, higher concentration of inhaled carbon monoxide from smoke can lead to higher concentration of carboxyhemoglobin versus inhaling just a sniff of smoke from a burning fire. Generally, higher levels of toxic exposure will therefore lead to greater response.

The dose-response model curve below shows that any dose of toxic chemical is harmful and the harm rises as the dose increases.

(figure available in print form)

Those engaged in spraying operations should be made aware of the effect of these chemicals on the soil, water, wildlife and *man* himself. As application of pesticides continue and residues continue to build up in the soil, it is almost certain that we are heading for double. Advance investigation as to the nature and effect of these chemicals and protective laws should in some way lower the risk of contamination to our natural world. We, the public, must assume these risks that the anthorities and condollers calculate. We *must* decide what action to take and we can only do so when we become informed and in full possession of the facts.

Alternative Methods of Controlling Pests

Can we fertilize our crops primarily with organic fertilizer and/or control pests by a combination of cultivation and biological methods?

The following alternative methods can be safer, more effective and ultimately discourage and inhibit pests.

1. *Crop rotation* in which the types of crops planted in fields are changed from year to year so that populations of pests that attack a particular crop do not have time to multiply to uncontrollable sizes.
    - adjusting planting times to ensure that most major insect pests either starve to death before the crop is available or are consumed by their natural predators.
    - planting rows of hedges or dees in and around drop fields to act as barriers to invasions by

insect pests.

2. *Artificial Selection, Cross Breeding and Genetic Engineering*

Varieties of plants that are genetically resistant to certain pest insects, fungi, and diseases can be developed. Insect pests and plant diseases can develop new strains that attack the once healthy resistant varieties. The use of genetic engineering can somewhat reduce pest damage.

3. *Biological Control*

Various natural predators, parasites and pathogens can be introduced or imported to regulate the populations of specific pests. (In the United States natural enemies have been used to control about seventy per cent of insect pests).

4. *Integrated Pest Management Program*

In this approach, each crop and its pests are evaluated as an ecological system. Pest control is basically an ecological problem and not a chemical problem. That is why using large quantities of broad-spectrum chemical poisons to kill and control pest populations eventually fails and ends up costing more than it is worth. The aim of this method is to keep pest populations just below the size at which they canse economical loss. Thus crop fields should be carefully monitored to check whether pests have reached an economically danaging level.

Occupational Hygiene in Agriculture

Even though pesticide use patterns have changed significantly during the past ten to fifteen years, developing countries still use mainly insecticides, many of which are acutely toxic.

Insecticides kill aphids, weevils, and other insect pests and are use on growing crops. As well as killing pests, they often also kill the insect predators which feed on them. Becanse insecticides do not degrade rapidly, they can be passed on in foods and can canse liver failure.

In considering the evaluation and control of agricultural pesticide exposures, it is useful to distinguish between workers who directly handle pesticides during application and those who are exposed primarily to residues following application.

Suggested Activities

1. Have students debate the topic: “Should DDT continue to be banned or should it be made legal again?”
2. Have students create a one-act play or dialogue between students who see a threat and those who do not see a threat or/and health risk in using *pesticides.* (This play can be performed in

class at the end of the unit during Earth Day week.)
3. Students may visit the Agricultural Center or the Department of Environmental Protection Agency in Hartford and lean how bugs and weeds are controlled in gardens, parks, and in private yards.
4. Have students develop rules regulating pesticide use in their neighborhood. Letters restricting the use of toxic chemicals could be mailed to the Environmental Protection Agency.
5. Invite a speaker, for example a Greenpeace representative, to give a presentation on altemative methods of *insect control* and the *threats to human health from pesticide.*

Mutagenesis

Mutation refers to any change in the genetic material of the cell that is transmitted to descendent cells. A mutation may affect a single nucleotide of the DNA, several nucleotides in a gene, several genes, large segments of one or more chromosomes or the entire chromosome.

Genetically engineered organisms might mutate and change their form and behavior. The altered genes transmit these traits from the parent to the offspring. Environmental factors are also capable of causing mutations and the evolution of new combinations.

New varieties of plants can be bred by mutations, crossing and grafting.

Permit students to respond to the following questions:

Do you think that a *mutation* is always for the worse?

Consider an intricate molecule of DNA strand replicating itself and getting a wrong building block into position, is it likely to do a better job because of the mistake? A mutated cell within one’s liver or bone will tend to perform so poorly and very likely unable to multiply. The normal cells surrounding this mutated cell will continue to multiply when necessary and soon crowd it out of existence. So the tissue as a whole stays normal despite the mutations.

On the other hand, what if the mutation just happen to affect the process of growth?

The normal cells in a tissue will continue to grow and multiply as needed to repair damaged cells, but a mutated cell may lack the mechanism to stop the growth at the right time. This rapid, continuous growth can lead to cancer. Thus, most mutations are for the worse, leading to the death of the offspring.

Suggested Activities

Divide the class into teams of four to discuss one of the assigned topics and then present their findings to the rest of the class.

1. Assume yon have been appointed to a technology risk-benefit assessment board. Explain why yon approve or disapprove of the widespread use of:
    a) drugs that would retard the *aging* process
    b) genetic engineering that would produce people with superior strength.
2. Students will debate the following issues:
    a) Do benefits of genetic engineering outweigh the risks?
    b) All smoking should be banned in public buildings, buses, subways and trains.
3. Have students list daily activities that help contribute to *pollution.* Then create a poster depicting this activity.
4. Have students discuss the pros and cons for the implementation of genetic engineering to improve the growth and appearance of tomato plants.

Lesson Plan #1

Hazardous Waste Sources/Disposal

Hazardous wastes are a major concern of our modern industrial society. These hazardous chemicals can have hanmful effects on our health and or the health of plants and animals. Hazardous wastes come from a variety of sources. The greatest quantities of these wastes are produced as by-products of manufacturing. Hazardous wastes can be produced by some service industries. However, some hazardous wastes are in our homes, and we often fail to dispose of them properly. Ideally, these wastes are reused or recycled.

The following activity is designed to provide students with an opportunity to learn where hazardous wastes are located in their community and where they are disposed.

Objectives
1. Identify some of the sources of hazardous wastes in their communities.

2. Identify approved disposal areas for the hazardous wastes.

Materials A map of the City of New Haven or local community
Four colored markers (blue, yellow, red, green)

Poster board, paper, pencil, crayons

Procedure

1. Begin a class discussion about the use of chemicals in your community (include chemicals produced by local industry and those used by individuals).
2. Inform students that they are going to identify the producers, consumers, and disposal location of these chemicals.
3. Circle the location of your school on the map in *blue.*
4. As a group, have the students identify and locate on the map sources of hazardous wastes in their community. Possible sources may include: gasoline stations, anto repair/paint shops, dry cleaners, hospitals, garden supply stores, farms, fast food restanrants etc. Locate these sources on the map in *red* .
5. Locate where the waste is disposed of in *yellow* (landfills, recycling centers).
6. Trace the most direct route of transportation in *green* between the sources of hazardous waste and the location of the waste disposal site(s).
7. Have the recorder from each group list *ten* potentially hazardous materials they or their families use around the house.

Questions for Extra Credit **:**

1. Write a one-page account of how these possible sources dispose of their hazardous wastes.
2. What could be done to reduce the risk of exposure to hazardous wastes in your community?
3. What could be done to reduce the amount of business and household hazardous wastes in the community?
4. What can you and your family do to prevent hazardous waste problems?

Extended Activity

Students will create a poster to be displayed in the classroom depicting various hazardous waste sites and the different types of clean up methods used on the sites. Also the students will show the movement of hazardous wastes once it is released in the environment.

Lesson Plan #2

Movement of Hazardous Wastes

Introduction: Our lifestyles are supported by many complex industrial activities that produce a variety of chemicals and chemical wastes. The EPA (Environmental Protection Agency) estimates that more than 70,000 chemicals are currently being used on a regular basis by manufacturers around the world. For example, the industries that produce our clothing, cars, medicine, paper, food, fuels, steel, plastic and electric components use and discard thousands of chemicals every year.

At home, we may use lawn chemicals, solvents, disinfectants, cleaners, anto products to improve our quality of life. Does this behavior considered risky to ourselves and the environment? At what point do you consider a substance or material to behazardous? A chemical that presents a threat or unreasonable risk to human health or the environment is considered a hazardous material— when it is produced, used or disposed of. When this material can no longer be used it becomes a hazardous waste.

The following are characteristics of a hazardous substance:

Ignitable: Capable of bursting into flames. Can irritate the eyes, skin and lungs e.g. gasoline, paint, furniture polish.
Reactive: Capable (under normal conditions) of changing into something else in the presence of other chemicals. When this happens a reactive substance can explode or create some poisonous gases, e.g. chlorine bleach and ammonia are reactive.
Toxic: Poisonous to people and other organisms. Can canse severe headaches, cancer or even death if swallowed or absorbed through the skin e.g. pesticides, weed killers.
Corrosive: Capable of chemically wearing substances away or destroying them. Capable of eating through metal, burn skin on contact and give off vapori that can burn the eyes, e.g. strong acids (HCL)

Once hazardous wastes are released, they can move about under the influences of water, wind and gravity. Dissolved and liquid hazardous wastes can occur in precipitation, runoff or surface water and can be moved down through the soil to ground water level. Contaminated ground water can also move into lakes, streams or rivers.

Objectives Students will:

1. Observe how a contaminant moves from land to water and between surface and ground water.
2. Experience the difficulty of cleaning up contaminated water.

Materials Each group will need:
One 500m1 beaker

Clean pea-size gravel to fill beaker 3/4 full

Three 300m1 paper cups

One pump dispenser from liquid-soap or hand-lotion containers

About 4 liters of water

One bottle of food coloring

Procedure:

1. Divide students into groups of four.
2. Have students display their posters titled “Hazardous Waste” from the previous activity on their desks.
3. Fill the 500m1 beaker 3/4 full of clean pea-size gravel.
4. Using a nail, punch 8-10 small holes in the bottom of one of the paper cups. When filled with water, this cup will be used to simulate rain.
5. Fill one paper cup (without holes) 3/4 full of water.
6. Provide each group with another paper cup and one pump dispenser.
7. Instruct students to hold the paper cup with holes in the bottom over the cup containing the pea-size gravel then pour enough water into the cup with the holes until all but the top one centimeter of the pea-size gravel is saturated.
8. Dig a hole in the center of the gravel to create a lake effect. The lake should be about 1/4 full of water. Have students observe the connection between the level of the water in the lake and how it corresponds to the level of the water in the gravel.
9. Add two drops of food coloring to the pea-size gravel surrounding the lake. The food coloring represents contamination from improper disposal of chemicals. Have students hold the paper cup with holes in the bottom over the cup containing the pea-size gravel at the location where the food coloring was added. Pour a small amount of water into the cup with holes and observe what happens to the contaminant.
10. Place the pump dispenser in the gravel down to the water level on the opposite side of the lake. Pump water into the paper cup with no holes. Observe the color of the water in the cup. Continue to pump until the color of the water being pumped changes to the color of the contaminant. Students should continue to add clean water and pump out contaminated water until the water becomes clear.

***Interpretive Questions* :**

1. How was the contaminant transported?

2. Was it easy to clean up the contaminated water?

3. Identify some risks involved in the movement of hazardous wastes.

4. List some clean up methods that can be used for hazardous wastes.

Lesson Plan #3:

Industry Comes To Towm

In this activity, students will reveal their attitudes toward *industry* through word association. Their perceptions of the following four industries are explored as a basis for discussion of the impact of industry on a community.

a) Computer production
b) Chemical manufacturing
c) Food processing
d) Oil refining

Objectives Students will—

1. Explore their attitudes toward various types of industries.
2. Discuss their perceptions of the impact of industry on their community.
3. Develop a list of concems to evaluate the impact of an industrial plant in the community.

Materials

1. A descriptive comparison of the four different industries.
2. Index cards
3. Calculator (optional) to compute average.

Procedure

1. Assign students to groups of four to encourage team work, greater discussion and learning.
2. Distribute one index card to each student. Tell the student that you are going to write the word *"industry" on the chalkboard for them to copy on their index* card. Tell students to record their first reaction to the word. Their reactions may be single words, phrases or ideas. Students will complete the same task for the word, *"factory"* . Allow enough time for the students to write their responses.
3. Ask for student volunteers to read their responses aloud for discussion. (Responses may be listed on the chalkboard).
4. Distribute worksheet below to students for them to rate four types of industriesin terms of their impact on a community.

Remind students that they should consider the impact of the industries on the entire community. Using a show of hands, determine how many students rated each industry highest and lowest in total score. Have them report both industries in case of tie scores.

Ask each group to average their scores for each industry and record themon the worksheet provided. Poll the groups to come up with a class average for each industry.

Discuss the students' responses to the averages, noting any differences between industry types. Ask students to explain reasons for the differences.

Emphasize the value of evidence in decision-making to the students.

(figure available in print form)

Comparing Four Industries

¥ Chemical manufacturing: Raw materials are brought in and processed to produce plastics for a wide range of goods. Various chemicals are used as raw materials, and plastics are the products.
¥ Computer production: Circuit boards are manufactured using special plastics, cleaners, and other materials. In order to produce the boards, raw materiais such as solvents and etching compounds are used. In each case, converting the raw material into the desired product requires the use of a variety of chemical processes.
¥ Food processing: Raw tomatoes are brought in. These are washed, mashed, pulverized, cooked, and made into a variety of tomato products. Some chemicals are used in addition to the natural ones in the tomatoes.
¥ Oil refinery: Crude oil comes in by pipeline and is processed to produce gasoline and other organic (carbon-containing) chemicals.

Lesson Plan #4

Clean Up Your Act

This activity simulates a tom meeting held to choose a method for cleaning up the contaminated ground water in the town. Using the posters made in Activity I, and the list of concems generated in Activity III, students will role-play different members of the community at a town meeting and lobby for particular clean up plans as part of a presentation to a student andience. Students in the audience will ask questions of the presenters, analyze what they hear, discuss the matter among themselves, and decide on the best plan to clean up the contaminated ground water in the town.

The various clean-up options can be:

a) containment
b) excavation
c) removal
d) incineration
e) shut-down the water source

Members of the panel will assume the different roles:

1. A concerned parent, New Haven resident.
2. An engineer from Excavation Specialists, Inc.
3. Vice President of Mobil Oil Co.
4. A Community Activist
5. The City Manager, Regional Water Authority, New Haven.
6. An Environmentalist
7. A Pathologist
8. Mayor of New Haven
9. An inventor, New Technologies, Inc.
10. A Gardner

Preparation for the Town Meeting

Students will prepare for their roles as members of the panel by conducting interviews with their role models in the community and do research work on the different clean-up methods.

- make name plates for each of the student actor
- prepare an agenda for the actors and the andience.(3-5mins. to make presentation).
- index cards may be provided for members of the andience to write questions down. . a microphone (optional)
- the city mayor can act as the moderator to welcome the andience and introduce the actors.
- camcorder
- select a method with the students to reach a decision e.g. consensus or majority vote.
- enlarge one of the posters prepared by the students showing the contaminated sites and sources of pollution for the andience to observe.
- present and discuss the following facts about ground water to the class.

Conclusion

Discuss the outcome and process with the students.

Ask the students what makes a decision a *good* decision.

Was everyone satisfied with the decision? Elaborate on your answer.

Extended Activity

Students may wish to contact the Regional Water Authority, New Haven, to learn more about the drinking water in their community water quality, safety and how the water is transported to consumers.

7. Facts about groundwater

You may wish to share the following in formation with the students.

1. 50% of the United States population depends at least partially on groundwater for drinking water.
2. 95% of rural households depend exclusively upon groundwater for their drinking water.
3. The federal government estimates that 2% of the groundwater is polluted from point sources. This is actually more of a threat than the low figure might indicate, since the pollution tends to be

near high population areas and thus affects more people. Also, this figure does not include non-point sources of pollution such as agricultural and urban runoff.
4. It is not uncommon for water from wells to exceed state maximum recommeded limits for various substances. In 1984-85, for example, one-fifth of all large wells supplying drinking water in the state of Califomia exceeded state pollution standards.
5. Infections from pathogenic bacteria, viruses, and parasites cause about fifty times as many cases of acute illness as chemical contamination of water.
6. Apart from microbes, virtually every contaminant causes an acute response only if the substance is present in large amounts. In the quantities in which most contaminants are present, the main risk is of chronic, low-grade illness, which is hard to diagnose.
7. Public water, even from high-radon aquifers, is typically held in air exposed reservoirs long enough for the gas to dissipate. The chief threat of radon contamination is from private wells.
8. Metal ions are present in higher concentrations in food, air, and cigarettes than they are in water.
9. Current evidence suggests that exposure to organic compounds through dietary and smoking habits poses more of a threat than water-borne exposure.
10. About 3-5% of the rural population uses wells in which the concentration of nitrates, which are implicated in stomach cancer, is greater than the federal standard of 10 ppm. However, vegetables in a typical diet provide nitrate levels in excess of this figure.
11. Salt (sodium chloride) enters groundwater through de-icing of roads and excessive pumping of water, mising the level above the recommended concentration of 20 ppm.
12. Water from public utilities must currently meet federal guidelines for 73 substances, with about 25 being added each year. The safe drinking water hotline can answer any general questions: 1-800-426-4791.

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