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ABSTRACT

This compilation of 57 activities adapted from 32 different publications addresses 5 of the 18 needs and recommendations for water quality curricula made by Elaine Andrews in the publication "Assessing National Water Quality Education Needs for the Nonformal Youth Audience." The needs include: approaching water-related ecosystems in a more integrated way; providing activities that better integrate ecology and science study with everyday life; rewriting materials to make them more appropriate for diverse audiences; making nontraditional learning choices more accessible; and reprinting high-quality materials no longer available. The hands-on activities are organized within a logical framework in five sections. The sections address the topics of: (1) the science of water; (2) the hydrologic cycle; (3) water uses; (4) water conservation; and (5) water pollution. Subsections within these topics address water properties; water movement, precipitation, transpiration, and evaporation; water needs; methods of conserving water; and types of pollution and necessary clean-up. The introduction includes a guide to using the book and the rationale for activity selection. (MDH)

Two H's and an O:
A Teaching Resource Packet on Water Education

Joe E. Heimlich
M. Claire Oberst
Lisa Spitler

July 1993

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The authors would like to recognize Elaine Andrews of the Wisconsin Extension Service for her assistance and significant insights on water quality education resources and programs.

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Introduction

In the publication "Assessing National Water Quality Education Needs for the Nonformal Youth Audience," Elaine Andrews presents a powerful list of needs about water education in particular, and about environmental education, in general. She and her team identified 18 very specific needs and recommendations for water quality curricula. This publication is not about filling all of those voids. Rather, this publication is designed to address five of those concerns without duplicating what has been done elsewhere while compiling and enhancing materials already in print.

The five needs that this publication addresses include:

- approaching water-related ecosystems in a more integrated way;
- providing activities that better integrate ecology and science study with everyday life;
- rewriting materials to make them more appropriate for diverse audiences;
- making nontraditional learning choices more accessible; and
- reprinting high-quality materials no longer available.

Two H's and an O is a compilation of activities designed to teach water quality issues from 32 different publications. These are not necessarily "the best" publications, nor even the "best" activities from any of these publications. The activities were selected and rewritten to conform with the concept of a teaching guide for teachers, volunteer leaders, scientists, or anyone who may need to share concepts of water quality with others. The learning in this compilation will come from the activities, not from a lecture or demonstration approach.

Arrangement of the Collection

This collection consists of 5 primary sections. Each section is then subdivided into broad categories that can help direct the educator to appropriate activities. When appropriate, the activities within the section also are organized within a logical framework. The five sections include:

I. The Science of Water

II. The Hydrologic Cycle

III. Using Water

IV. Water Conservation

V. Water Pollution

How to Use This Guide

Each of the activities selected for this collection can "stand alone" with independent learning outcomes. Yet, few educators teach isolated activities. This arrangement is designed to allow the educator to construct a teaching segment on water that is congruent with that individual teacher's desires and beliefs about teaching and learning.

Some of the activities begin on a very basic level of information. Some activities can easily be adapted to related, more in-depth activities and experiences and some include suggestions for extending or expanding the experience constructed in the learning activity.

Each activity includes a description of the purpose of the activity, the educational constructs used in the activity, the materials necessary for completion of the activity, and the source from which the activity was adapted (if any).

An educator may choose to select one or two activities from each section of the guide to create a broad understanding of water. Alternatively, an educator can opt to secure a depth of understanding by conducting many activities from one section of the guide. The goal of this publication is to make available to educators some of the often used and some of the hard-to-find activities that effectively convey concepts related to water and humans.

Rationale for Selection of Activities

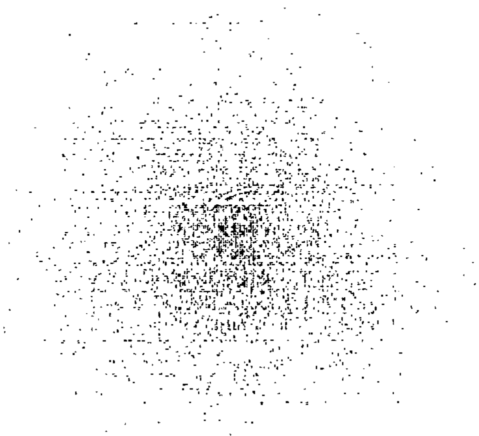
To determine which activities to include, several qualitative and quantitative selection criteria for the activities to be included were used. The quantitative criteria included:

- general availability of resources needed for conducting the activity
- a broad application of the learning to practical situations
- adaptability of the activity to multiple age groups
- doable within a standard class period or over a short term.

Perhaps more difficult to construct were the underlying, qualitative concepts that were considered important in the construction of this guide. Critical thinking, problem-solving and decision-making were considered cruicial components of adaptable, successful educational activities.

The goal of this selection of activities is to provide learners with experiences in the hydrologic cycle and to explore the human interaction with that cycle. Further, the nebulous goal of environmental stewardship lies in the core of all environmental activities. Those activities that tend to promote 1) positive attitudes toward the environment, 2) creative thought around the environment and, 3) understanding of human relationships with the rest of nature are those activities that come from the experiential base of the learner. This base is constructed by creating experiences that broaden the sensorial awareness and affective understanding of the learner.

Two H's and an O



Section I - The Science of Water

Where Is Water?

Water, Water Everywhere

Primary Source
Purdue University Cooperative Extension Service. *Indiana's water riches: Instructor's guide* (p. 9). West Lafayette, IN: Purdue University Cooperative Extension Service.

Teaching Outcomes
Students will see the relationship between available freshwater and the water supply of the Earth.

Materials
gallon (3.8 liter) plastic jug
bucket
clear measuring cup
water
medicine dropper

Background

Water exists on the earth in three forms: solid, liquid, and gas. All surface and ground water is found in these states, as well as fresh and salt water. On the Earth, nearly 97.2% of water is found in oceans, 2% is found in icecaps and glaciers, .62% of the water is ground water, .009% of water is in freshwater lakes, .008% is in inland seas or salt lakes, .001% of Earth's water is found in the atmosphere and .0001% of water is in rivers.

Procedure
1. Fill the gallon jug with water. This represents the earth's total water supply.
2. From the gallon jug, have a student pour one ounce (1/8 cup or .03 liters) water into the measuring cup. This water represents the earth's land water. In this activity, land water is water found on and under land, and has the potential for human use. It may be drinkable, but water can be in salt lakes and not drinkable.
3. The water left in the jug represents water stored in the oceans and iceburgs.
4. Remove a dropper full of water. The water in the dropper represents all of the good quality water found in freshwater lakes, rivers, and underground.

5. Drop one drop from the dropper into the bucket. make sure the students are quiet so they can hear the drop. The drop in the bucket is their state/region's share of drinkable water. A foil pie pan in the bottom of the bucket makes a loud "ting."
6. Discuss the importance of good water for life on the earth. What does this "drop in the bucket" mean?

Where Is Water?

How Wet Is Our Planet?

Primary Source

U.S. Environmental Protection Agency. (1991). *Always a river: Supplemental environmental education curriculum on the Ohio River and water, grades K-12* (p. 87-90). Washington, DC: Environmental Protection Agency.

Teaching Outcomes

Students will compute the amount and distribution of water on the earth in oceans, rivers, lakes, ground water, icecaps, and the atmosphere, and make inferences about the importance of responsible use of water.

Materials

A globe (12 inches); five gallons (19 liters) of water poured into a five or ten gallon (19 or 38 liter) aquarium; writing materials; calculators, measuring cup; one quart (1 liter) container for every 3 students; one tablespoon for every 3 students

Background

Water exists on the earth in three forms: solid, liquid, and gas. All surface and ground water is found in these states, as well as fresh and salt water. On the Earth, nearly 97.2% of water is found in oceans, 2% is found in icecaps and glaciers, .62% of the water is ground water, .009% of water is in freshwater lakes, .008% is in inland seas or salt lakes, .001% of Earth's water is found in the atmosphere and .0001% of water is in rivers.

Procedure

1. Divide the classroom into groups of three. Give each group a quart or liter container and a tablespoon.
2. List the above percentages of water on the chalkboard or a poster. Show the students the five gallons of water and tell them how much is there. Provide the students with the following quantity: 4 gallons = 1,280 tablespoons (one gallon = 3.8 liters).
3. Have students assume that the 5 gallons represent all the water on Earth. Ask students to calculate the volume of water for each category using the percentages given. This will require the use of decimals. Remind students that for multiplication, all the decimal places must be shifted two places to the left so that 97.2 percent becomes 0.972 before the multiplication (.0972 x 1,280 tablespoons = 1,244.16 tablespoons). The following values result:

Oceans	1,244.16
Icecaps/glaciers	24.60
Groundwater	7.936
Freshwater Lakes	.115
Inland seas/salt lakes	.1024
Atmosphere	.0128
Rivers	.0012

4. Ask the students to calculate the amount of fresh water potentially available (in tablespoons) for human use. The following calculation will be performed:

   Icecaps/glaciers + groundwater + freshwater lakes + rivers = total x 1,280 tablespoons

   (2.6291 x 1,280 T = 33.6 tablespoons)

5. Ask each group of students to take 34 tablespoons of water from the aquarium, put it in a container and take the container of water back to their workplaces.
6. At their workplaces, ask the students to remove the amount of water represented by all freshwater lakes and rivers (about .111 tablespoons or one-tenth of a tablespoon). Then ask students to extract the amount represented by just rivers (less than 1/1000 of a tablespoon) which is less than one drop. Discuss the relative proportions with the students.
7. Discuss that there is a limited amount of freshwater on our planet and that the amount of usable water available to humans is a very small percentage of the total water on the Earth. Discuss how all species depend upon this minute percentage of water for their survival. Also make the point that most freshwater is locked up in icecaps/glaciers and that not all ground water is readily available for human use.
8. Summarize the activity by using a globe to illustrate that if the Earth were the size of a 12 inch diameter globe, less than one-half cup (8 tablespoons) of water would fill all the oceans, rivers, lakes, and icecaps.
9. Conclude by emphasizing the importance of keeping the Earth's waters clean and healthy and of using water wisely and responsibly. Ask what steps students can take to conserve water.

Where Is Water?

Oceans, Ice, and Us

Primary Source

Southern Arizona Water Resources Association. (1984). *A sense of water: Teaching materials for elementary grades* (pp. 9-10). Tucson, AZ: Southern Arizona Water Resources Association.

SAWRA

Teaching Outcomes

Students will appreciate the relative proportions of salt water and fresh water on earth and acquire the basis for understanding the need to conserve limited fresh water resources.

Materials

5 or 10 gallon aquarium or large clear container; 3 drinking glasses; measuring cup; medicine dropper; food coloring; salt; teaspoon; water; 5 clear containers that can hold 2 1/4 cups; 2 clear containers that can hold 1 1/2 cups; 2 clear containers that can hold 1/2 cup

Background

The earth and its atmosphere contain about 940 million cubic kilometers of water. Although the water exists in solids, liquid, and gas, the relative amounts of which are varying constantly, the total quantity remains unchanged. Most of the water, more than 97%, is in oceans; about 2% is tied up in glaciers and icecaps; and about 0.6% is in the atmosphere. Thus less than 0.1% of all the earth's water is on the land surface in streams, rivers, and lakes at any given time and is available for human use.

Procedure

1. Fill an aquarium with 5 gallons of water. This represents the total amount of water on our ecosystem, the earth. Using a world map, have students locate and identify the oceans. Record the names given to these bodies of water on the chalkboard. Discuss salt water.

2. Fill 3 glasses with water. Have a student conduct a taste test. Have the student drink water from one glass. It should taste fresh even though there are some salts naturally present. Add a "pinch" of salt to the next glass and stir the water. The water may taste fresh or slightly salty. Add a teaspoon of salt to the water in the last glass and stir the water. The student's taste buds should react vehemently toward the salty water. Explain that this glass of water has about the same salt content as sea water.

3. Discuss the practicality of using ocean water for human use such as drinking, bathing, watering plants, etc. Using the aquarium, ask students to predict how much water in our ecosystem is salt water.
4. Remove 2 1/4 cups of water from the large container. Tell the students that this represents the total supply of fresh water in the system. Put this into a container next to the larger container. The remaining water in the large container represents salt water.
5. Ask the students to define/describe a glacier. Using a world map, locate some of the areas where glaciers are found. Ask if any students have seen a glacier. Do they think glaciers are rare features on our planet. Ask the students to predict the amount of fresh water that is locked up in glacier on our planet. Take 1 1/2 cups of water from the container holding 2 1/4 cups. This water represents the water in polar ice caps and glaciers.
6. Discuss briefly that the atmosphere also contains moisture which we can sometimes see in the form of clouds and which can fall to the earth as rain, snow, etc. Ask students to describe what happens to rain after it reaches the ground. Mention that water runs into streams, lakes, ponds, the ocean; is used by plants and animals; and evaporates back into the atmosphere. Be sure to discuss that some water falls onto soil and soaks in to become groundwater. Ask the students to predict how much of the remaining fresh water is atmospheric or groundwater. Pour 1/4 cup of water from the container number 2. This represents water in soil or in the atmosphere.
7. There is 1/2 cup of water remaining from the original 2 1/4 cups removed from the tank. Take 5 drops out of the 1/2 cup with the medicine dropper. These five drops represent the amount of fresh water available to humans. The 1/2 cup less five drops, represents surface and groundwater that is unavailable for human use because of technological or economical reasons or is polluted.
8. Put different colors of food coloring in the jars or bottles representing the total salt water supply, the locked up water (technologically unavailable), the polluted or inaccessible water, and fresh water available for humans. Identify and display.

Going Further

1. Discuss the proportions of salt water and fresh water of this planet and why humans are concerned about protecting the usable water.
2. Have the class make a display for the school bulletin board or display case to share this concept, or make a presentation-demonstration to another class.
3. Using 100 marbles, have the students separate the marbles into piles representing each of the water sources. Of the 100 marbles, one marble will represent the less than 1% of water available for use.

Source: University of Vermont Extension Service. *The water around us*. Burlington, VT: University of Vermont Extension Service.

Where Is Water?

Setting Up a Mini-Ecosystem

Primary Source
Haney, R. (Ed.). (1978). *A sourcebook of marine activities developed in the Milwaukee Great Lakes summer education program, 1977 and 1978* (p. 53). (ERIC Document Reproduction Service No. ED 207 851)

Teaching Outcomes
Students will study the interrelationships between organisms and their physical and biotic environments and discover what effect the variations of tolerances have on the diversity and distribution of organisms.

Materials
water from a lake or river
organisms obtained by seining the river or lake
wide mouth jars or small aquaria

Background

All organisms (including humans) have both dependence on and interrelationships with the immediate environment. We can begin to understand the human relationship to water by first looking at a water community.

Procedure

1. Have students take the water and organisms obtained from a river or lake and fill the jars or aquaria about 1/2 full. Make a list of things they observe in the mini-ecosystem. How many populations are represented? Keep a record of the plant and animal relationships observed.
2. Let students observe changes in the system from day to day. What happens? Why? How might they better observe what is in the water?
3. Put the list of observations on a data sheet to record temperature, pH, D.O., CO2, etc. What tests might they perform? Various science education catalogues have water testing kits that might measure some of these factors.

Where Is Water?

Habitat Detectives

Primary Source

National Aquarium in Baltimore. (1989). *Living in water: An aquatic science curriculum for grades 4-6* (p. 191). Baltimore, MD: National Aquarium in Baltimore. (ERIC Document Reproduction Service No. ED 309 071)

Teaching Outcomes

Scientists frequently work together not only in the lab or field, but through written communications.

Materials

posterboard
colored pens or crayons
construction paper
tissue paper
scissors
glue

Background

This is a group project which combines library research skills with verbal and visual communication. It requires practicing the organizational and leadership skills required for working in groups. Divide the class into groups of 3 or 4 students. You may choose students with their personal abilities in mind or you may wish to make them work in new groups by having them draw their group number. Each group has one aquatic habitat to research. These are some possible habitats:

small to medium size lake
river where it flows into the sea (estuary)
ocean where the water is deep
rocky coast of ocean
sandy beach
freshwater swamp
freshwater marsh
salt marsh
kelp forest
salt lake
coral reef

Procedure

1. Assign each group a water habitat. Each group is responsible for discovering through library research the characteristics of the habitat, the types of life forms that exist in the habitat, and unique features of that habitat.
2. Have each group prepare a poster of their habitat using the media available. They should attempt to illustrate the habitat and its manner of supporting life on their posterboard.
3. Allow each group time to prepare a presentation of their habitat. During one class period, have all groups share their findings with each other.
4. Discuss both the findings and the process of this type of research and communication. What is similar among habitats? What is different? How did groups discover their information? What did they use besides encyclopedias? What made sharing information easier for presentors? For listeners?

Water Behaviors

How Much, How Fast, How Big?

Primary Source

Springfield Public Schools. (1971). *Environmental center for our schools: Curriculum guide, grades 4, 5, 6.* Springfield, MA: Springfield Public Schools. (ERIC Document Reproduction Service No. ED 063 151)

Teaching Outcomes

To perceive and measure velocity, volume and capacity of a moving body of water

Materials

- stick
- yardsticks (one per group of three or four)
- tape measure (one per group of three or four)
- paper/writing implements

Background

Liquids move unless contained. We see this every time we spill a glass or bump a bowl of soup and splash it on the table. Although it is hard to sometimes see the speed and strength with which liquids move, we can measure the effects of this movement.

The volume, capacity, and velocity of a stream or river or drainage ditch may, in pleasant weather, seem to be relatively unimportant. But these three factors are very important during dry and wet seasons. Floods, and especially flash floods, are waterways that overfill their capacity and the velocity of the movement becomes destructive.

Procedure

1. The class will need to go to a shallow stream, river, or water ditch. Ask how much water is in the bed. Ask if the water is moving. How can we tell? Can we measure how fast it is moving? Although we may not be able to measure undercurrents, we can measure the surface currents. Ask if any of the students have suggestions as to how to measure the "velocity" of the water.
2. Adapt the students' ideas to fit with the following. Station one student on the bank and another student about 50 feet upstream. Have the student upstream toss a stick in the water. Other students should record the length of time it takes for the stick to float to where the first student is standing.
3. We can compute velocity with these known facts:

   Velocity = distance traveled divided by length of time (V = D/T)

Have the students compute the velocity. Then discuss how the speed of moving water may change the earth's surface. Does the speed of a stream affect the animals and plants living in the water? Beside the water? Can all water animals or plants live in a fast moving stream? Why or why not?

4. Divide the class into groups of 3 or 4 students. Each group should have a yardstick and a tape measure. Ask each group to measure the width of the bed in several places and find an "average" width within a twenty foot span. Then, have each group measure the depth of the stream in several places and find an average depth in the same twenty foot span.
5. How can we compute the "volume" of the water? Volume equals width (in this case average width) times length times depth (in this case average depth). What does volume really mean in relationship to the stream or water bed? How does this relate to the "capacity" over time for water?
6. Why might it be important to know the capacity, volume, and velocity of a stream or body of water?
7. Does the amount of water change from season to season? Does the riverbed ever change? When?

Water Behaviors

I'm Melting...Faster?

Primary Source

Carson City/Storey County Cooperative Extension. *Cscape in-school curriculum* (p. 14). Carson City, NV: U.S. Department of Agriculture, Extension Service (ent 90 EWOI-1-9234)

Teaching Outcomes

To discover factors that enhance/ inhibit drying and melting

Materials

large ice cube(s)
little pieces of ice
2 glasses
water
two pieces of cloth the same size and type
tray

Background

The principles of water changing states (solid to liquid to gas) are constant, but there are factors that affect the speed with which these changes occur.

Procedure

1. Talk about the three states of matter, solid, liquid, and gas. Ask the students about water: what is it like in each state? How can we see it in the various states?
2. How does matter change from one state to another? H_20 has some unique characteristics in that we can see evidence of it changing states. How can we do that?
3. Ask what factors may alter the way H_20 changes states (temperature, surrounding matter). Tell the students that we are going to compare some changes and observe some factors that may help alter the speed of change.
4. Have students put equal amounts of water in each glass. In one glass, have them put a large ice cube. In the other glass, have them put in an approximately equal amount of bits of ice.

5. Place the glasses in a warm spot. Which ice melts faster? Why? What does this suggest about water and ice in nature? In the refrigerator?
6. Using the glasses and water from the melt experiment, have students place the cloths in the glasses to completely wet the fabric. Have them squeeze out most of the water.
7. Place the cloths on the tray-one cloth should be spread evenly, the other should be crumpled. Which do the students believe will dry faster? Why?
8. Which of the cloths did dry faster? Why might that be?
9. What other factors could alter the speed of H_2O changing states? How might we test for that?
10. Have the students ever seen any indication of these types of changes in the natural world? Is any of this important in the natural world? Why or why not?

Going Further

1. Have students form teams. Each team can create and conduct experiments to test for factors that affect the changing of states as identified in the last activity above. Some ideas might be adding salt, vinegar, soap, or sugar to the water.

Water Behaviors

Boil, Boil, Toil and Trouble

Teaching Outcomes

To discover how to raise or lower the boiling point of water; to discover the differences between boiling points of salt and fresh water

Materials

thermometer (measuring from 32 degrees F to 220 or more degrees F)
distilled water
tap water
3 small deep pans
2 or 3 stove burners
salt
stirring rod

Background

Although we often say the boiling point of water is 212 degrees F, this is the boiling point of pure water at sea level. Degrees of salinity, chemicals in the water, and altitude are among some of the factors that can change the temperature of boiling. It's not absolute!

Procedure

1. Ask the students if any of them know the boiling point for water. Challenge them if they respond with, "how do you know?" Tell them we can try to see if we can change the boiling point of water. Place two cups of distilled water into each of the three pans. In one of pans, have a student dissolve three tablespoons of salt. Identify the pans as "Tap Water," "Salt Water," and "Control." Measure and record the water temperatures. Have students predict the temperatures at which each pan of water will come to a rolling boil.

   A chart might have these types of headings:

Time	Control temp.	Observation	Salt temp	Observation

2. Place each of the pans on burners of equivalent diameter and turn on high heat. Regularly measure and record the temperature of water. Note visual differences in the water such as bubbles and steam. (Note— be careful not to let the thermometer touch the bottom of the pan as that would measure the temperature of the burner!)
3. After the waters boil, discuss differences between the waters. How close were original estimates of boiling point? Did we "change" the boiling point of water? How?

Going Further

1. Have the students construct graphs in which they plot the data indicating the change of the temperature of the "pure" water and of the salt solution as time progressed.
2. Discuss other factors that might vary the "boiling point" of water.

Water Behaviors

The Disappearing Act

Primary Source

U.S. Environmental Protection Agency. (1991). *Always a river: Supplemental environmental education curriculum on the Ohio River and water, grades K-12* (pp. 111-13). Washington, DC: Environmental Protection Agency.

Teaching Outcomes

Students will compare rates of solubility in water and define factors affecting rates of dissolving

Materials

water
table salt (canning or kosher)
granulated table sugar
cornstarch
large clear glass jar
package of a dark flavor of unsweetened drink powder
PER GROUP:
3 clear plastic straws
three plastic straws or stirrers
a teaspoon
a graduated measuring cup
three pieces of tape
pencils/pens
paper

Background

A solution is a mix of dissolved substances in a liquid. Water can hold many substances. Some of these substances are vital to sustaining life within the water. These substances include oxygen and some nutrients. Fish and aquatic plants require oxygen to survive—just because they live in an environment where human lungs cannot be used does not mean oxygen is not important. In fact, water in its purest form is comprised of two atoms of hydrogen bonded with one atom of oxygen. Oxygen enters the water in many ways; through photosynthesis, through precipitation, and through mixing of waters.

Procedure

1. Show the students a large, clear glass jar of water and a package of unsweetened drink powder. Ask the students to predict what will happen if you pour the drink powder into the water. Do they all agree? Pour the powder in and see what happens (it should sink and then begin to dissolve and spread through the water). Ask students if they can suggest a means of speeding the process of dissolving (stirring, using hot water). Introduce the word "solution" for the mixture and the word "dissolve" for the process of mixing completely.

2. Ask the students to name other substances found around the home that would dissolve in water. List them on the chalkboard. Show the students the table salt, sugar and cornstarch. Ask them to predict whether each will go into solution.

3. Divide the students into groups of three or four. Each group should label one clear plastic cup as "salt," another as "sugar," and the third as "cornstarch." Fill each of the cups with about the same volume of water at room temperature. leave about 1 inch of space at the top.
4. Add 2 heaping teaspoons of salt to the cup labeled "salt," 2 heaping teaspoons of sugar to the "sugar" cup, and 2 heaping teaspoons of cornstarch to the "cornstarch" cup. Have the students observe what happens for two minutes and record their observations. Ask the students to stir each cup by making a circle around the edge of the cup with the stirrer ten times. Was there a change? Repeat, stirring ten times in each cup until one substance has completely disappeared or dissolved. Record how many times this cup was stirred. Continue stirring and observing the other two substances to find out which dissolves (or disappears) next fastest. Again, record the results. Each group should have three numbers (the number of times each substance was stirred before it was dissolved).
5. Have each group post its results on the chalkboard. Compare the results among the groups and discuss. (Sugar or salt may be faster depending on the size of the crystals in the particular brand. What happens to the cornstarch may be a subject of debate. Some students may say it is in solution, others may not.) For each substance, add all of the numbers obtained for that substance and divide by the number of groups to get an average result. Have students make a bar chart of the average numbers.
6. Save two sets of the solutions and place them in a safe place overnight. The next day, ask students to observe what has happened to the solutions (the cornstarch will have settled out). What conclusions can be drawn from these observations? (Not all substances go into solution and some dissolve faster than others.)
7. Ask the students if gases, such as oxygen, go into solution in water. Help the students understand how oxygen enters the water and how it is used by organisms. Discuss with students the importance of oxygen to all living things.

Going Further

Ask students to design an experiment to test whether substances go into solution faster in hot water. They should be able to state the central question to be addressed through the experiment, design a procedure for carrying out the experiment, and determine an appropriate control for comparison. Then have the students carry out the experiments they designed.

Water Behaviors

Permeability

Primary Source

Nickinson, P. (1986). *Sandcastle moats and petunia bed holes: A book about groundwater* (p. 10). Blacksburg, VA: Virginia Water Resources Research Center. (ERIC Document Reproduction Service No. ED 312 141)

Teaching Outcomes

To understand how water moves

Materials

- 8 plastic cups
- clay
- sand
- gravel
- soil
- water
- graduated cylinder
- colored water
- stopwatch
- pencils or matchsticks

Background

Water travels not only through air, but also through soil and rock. The rate with which water is able to be taken into material is the porosity—the movement of water through material is permeability. Many people throughout the world depend upon groundwater for drinking. This water is often contained within a porous rockbed called the aquifer. The water in the aquifer is recharged by surface water, which is why groundwater is considered threatened by chemical spills and other forms of land pollution. We can look at the permeability of soil and rock through some simple activities.

Different sizes and shapes of particles create different sized pore spaces. The ease with which water passes through (permeability) in unconsolidated deposits like the ones in the following demonstration is determined by the smallest of the gaps, as this is where water would start to back up. In a solid rock, however, water's ability to pass through depends on how well the pores are connected to each other.

Procedure

1. Have students punch four small holes in the bottom of each cup. Each cup will receive a different earth material or mixture of materials.

Cup 1: clay	Cup 5: gravel + sand
Cup 2: sand	Cup 6: soil + gravel
Cup 3: gravel	Cup 7: soil + sand
Cup 4: soil	Cup 8: soil + gravel + sand

For each of the cups 5-8, use larger containers to mix the materials thoroughly before beginning the next step.

2. Let students fill each cup with its required mixture or material so that the level of the earth material is one inch from the lip of the cup. Number each cup or label with mixture contained in each. Have students measure and pour 25cc of water into each cup (if using very large cups, use 50cc water). This first water is to be drained and discarded as its purpose is to be sure all materials are saturated before timing how fast excess water travels through. Explain this to the students and ask them why we should saturate the materials first (some materials will retain some of the timed water and cause an inaccurate reading).

3. Place pencils or matchsticks on a table or desk. Set the cups on the pencils or matchsticks so the water can drain through the holes. Wait ten minutes. For each cup, two partners are needed. One will operate the stopwatch and the other will pour the water. With the stopwatch ready, pour in 25cc of colored water. Start the watch as soon as all the water has been poured in (quickly). Stop the watch when the first drop of colored water appears. Record times for each of the eight cups.

4. Discuss the following questions:

    1. Which earth material was the most permeable? The least?

    2. How did mixtures fare against single-material cups?

    3. All of the earth materials were "unconsolidated" so that permeability was a function almost entirely of the materials' porosity. How is this different from permeability in a solid rock?

Going Further

1. The rate of water travel equals soil distance divided by time travelled. Find the rate for each cup. R = D/TI-C

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Hot and Cold

In Hot Water!

Primary Source

U.S. Environmental Protection Agency. (1991). *Always a river: Supplemental environmental education curriculum on the Ohio River and water, grades K-12* (pp.104-106). Washington, DC: Environmental Protection Agency.

Teaching Outcomes

Students will study the relationship between water temperature and density, define a thermocline, and discuss the ecological significance of stratification and mixing.

Materials

hot tap water
cold water (from refrigerator or ice water)
four clear plastic cups per group
a plastic spoon per group
a bottle of food coloring per group

Background

Water within a larger body tends to have various "habitats" within it based on many factors. One factor is the temperature of the water. Water has density, and warmer water is less dense than cooler water. This causes the warmer water to rise and sit on top of the cooler water. The point at which the layers meet is a thermocline.

Procedure

1. Divide the class into groups of three or four. Give each group four clear plastic cups, a plastic spoon, and a bottle of food coloring.
2. Ask each group to fill two of its cups with hot tap water (but not so hot that it could burn skin) and the other two with cold water, and to take these cups back to their workstations.
3. At the workstations, have the students add a few drops of coloring to one of the hot water cups and one of the cold water cups. next, ask the students to take a spoonful of the cold colored water and very carefully pour it on the surface of the hot clear water. Observe what happens.

4. Now ask the students to try the reverse: take a spoonful of hot colored water and pour it on the surface of the cold, clear water. What happens?
5. What would happen if hot colored water were added to clear hot water? Or if cold colored water were added to cold, clear water? As a control, demonstrate or have a couple of students demonstrate. Were the ideas supported by the observations?
6. Discuss how a body of water can be "stratified" or layered with two totally different kinds of places (in terms of temperature) for plants and animals to live. Ask students if they know what the zone between the two layers (warm and cold) is called? (A thermocline.) Ask students if they have ever noticed a sharp drop in temperature while swimming and explain that this is the thermocline.
7. Ask the students to stir the water and observe what happens. Discuss what "stirs" real water (wind, surf, rivers entering lakes or oceans, etc.) Discuss why mixing is ecologically important in a body of water (for example, it provides oxygen and helps transport nutrients.)

Going Further

Investigate what happens when a pond or lake freezes by having students make a model pond. Fill a plastic cup with cold water. Put several polystyrene foam cups inside one another and then place the plastic cup inside the foam cups and place all of them into a freezer. Check the cup every 15 minutes. Where does the ice form first? Record when the ice forms and where. If a pond works in the same way, where does the ice form first? Remove the cups from the freezer before the water freezes solid as the cup may "burst."

Demonstrate why ice floats by filling a clear plastic cup with cold water. Draw a line at the top of the water in an insoluble marker. Put the water in a freezer overnight. The next morning, compare the level of the frozen water with the line. What has happened to the water? What does this say about the density of frozen water compared to liquid water?

Hot and Cold

Cold Water Action

Primary Source

Foley, A. (1984). Summer stratification and fall overturn—In a jar. *Journal of College Science Teaching.*

Teaching Outcomes

Students will learn how cold water travels

Materials

piece of string about 1 foot long
soft drink or juice bottle (small—10 ounce)
iced tea jar
food coloring
ice cube tray
water
freezer (in advance)

Background

When heated, water expands and rises. The warmest water in a body of water is found nearest the surface. This principle is true even when comparing cold waters; the warmer will always rise.

Procedure

1. In advance, mix some food coloring in about two cups of water. Put the colored water in an ice cube tray and place it in the freezer.
2. Tie the string around the neck of the bottle to make a long handle. Have students break up the colored ice cubes and put the ice into the bottle.
3. Have other students fill the iced tea jar with cold tap water until the water reaches about two inches from the top of the jar.
4. Use the string to gently lower the bottle into the jar filled with cold water. Be careful to keep the small bottle upright. As the bottle drops, it will gradually release a flow of colored water. Where does this colored water go in the jar? Why? How long does it stay there? Why? How does this illustrate the movement of warm water? How does this apply to large bodies of water such as a lake?

Hot and Cold

Heat Capacity and Climate

Primary Source

Haney, R. (Ed.). (1978). *A sourcebook of marine activities developed in the Milwaukee Great Lakes summer education program, 1977 and 1978* (p. 39). (ERIC Document Reproduction Service No. ED 207 851)

Teaching Outcomes

To describe the ways in which the water may affect climate of surrounding areas and to introduce the concept of heat capacity of water and its relation to that of other materials.

Materials

6 pie tins
water
5 different sands and soils
6 thermometers

Background

The heat holding capacity of a large body of water can have a tremendous impact on a city or community on the shore. In the Great Lakes, there are "snow belt" regions in which the "lake effect" is continually mentioned in the winter. Why are there such differences in temperature between homes on a beach and homes further inland? This activity explores the heat capacity of water and how it affects climates.

Procedure

1. Have students set up the six pie tins, each filled with equal masses of different materials such as water, sand, crushed rock, dark soils, etc.
2. Initial temperatures of the different materials should be taken and recorded. (Note, allow the materials enough time to reach room temperature so that the initial measurements will be fairly similar.)
3. Have students place the tins in direct sunlight and record temperatures of each taken at one minute intervals.
4. After approximately ten minutes, remove the pans from the sunlight and continue to record the temperatures at one minute intervals for about ten minutes as the materials cool.

5. Which materials heat most quickly? Which materials cool most quickly? Which materials heat and/or cool most slowly? What does this suggest regarding the "heat capacity" or ability to hold heat of each material? How would this affect the surrounding life forms?

Hot and Cold

The Effect of Temperature on Breathing Processes of Goldfish

Primary Source

Haney, R. (Ed.). (1978). *A sourcebook of marine activities developed in the Milwaukee great lakes summer education program, 1977 and 1978* (p. 62). (ERIC Document Reproduction Service No. ED 207 851) .

Teaching Outcomes

Students will observe the effect of temperature on goldfish breathing and relate this to other life forms

Materials

large jar
goldfish
ice cubes
watch
thermometer

Background

Temperature of water has an effect on the life forms that can live within it. Most plants and animals are adaptable to some extent to varying temperatures. Goldfish live in fresh water where they eat small plants and insects. In an aquarium they typically eat prepared goldfish food or water fleas and ants' eggs. Like all other living creatures, goldfish need oxygen and the goldfish diffuses oxygen into its blood through its gills. In this same manner, carbon dioxide is expelled from the fish's blood.

Note: Students should take care not to change the temperature of the water too quickly or too often to avoid stressing the fish. Respect for all life forms can be an important component of this activity.

Procedure

1. Discuss how plants and animals (including the human animal) adapt to different temperatures. Or do they? How about animals in water? Or plants in water? Do they adapt? How?
2. Observe the goldfish in the large jar. Where are the gill covers on the fish? What happens to these covers when the goldfish breathes?
3. Count the number of times the gill covers open in one minute and record it on a chart along with the temperature of the water during the "counting."
4. Wait four minutes and add one cube of ice. Repeat the procedure in number 3. Continue for several more ice cube additions.

5. What happened to the goldfish's breathing? Why? Does this happen to humans? What does this suggest about animals that live in colder water or warmer water?

Going Further

Plot a graph of the number of gill cover movements versus the temperature. Have students explain the meaning of the chart to students in other classes.

Note: If the fish is to be returned to a larger aquarium, the temperature in the large jar needs to be slowly brought back to the temperature of the aquarium.

Estuaries

Hard Water? Soft Water?

Primary Source
Illinois Environmental Protection Agency. (1988). *Water: The liquid of life*. Springfield, IL: Office of Public Information.

Teaching Outcomes
Participants will test the effects of minerals in water.

Materials
- cold tap water
- 3 jars with lids
- distilled water
- measuring spoons
- measuring cup
- Epsom salt
- soap flakes (not detergent)
- masking tape
- pencil

Background

Depending upon the surrounding soils and other geology, minerals are taken into the water. The amount of minerals determines whether the water is "hard" or "soft." This activity explores the difference and encourages the students to discover the relationship of hard and soft water and use.

Procedure

1. In two jars, put a half cup of cold tap water in each.
2. In a third jar, put a half cup of distilled water. Distilled water is as soft as water can get.
3. In one of the two jars containing cold water, put a half teaspoon of Epsom salt. Label the jar. Put on the lid and shake the jar to mix the salts. You have just made hard water!
4. Put a half teaspoon of soap flakes in each jar. Put on the lid and shake each jar five times.
5. In which jar is the foam most sudsy? Which jar has the least amount of suds? Why do you think this is so? Compare how soft your tap water is against the distilled water and the hard water you made.

Going Further

Discuss why there might be differences between water sources. Do the students have examples of differences?

Does tap water have anything in it? Would that affect the outcomes of this experiment? What would happen if the water were salt water like the ocean? Can you try it and see?

Estuaries

The Layered Look

Primary Source

National Aquarium in Baltimore. (1989). *Living in water: An aquatic science curriculum for grades 4-6* (p. 35-38). Baltimore, MD: National Aquarium in Baltimore. (ERIC Document Reproduction Service No. ED 309 071)

Teaching Outcomes

Students will discover how stratification occurs in estuaries where fresh water meets saltwater, observe how fresh water flows above the saltwater layer, and predict mixing.

Materials

Colored markers or crayons; two clear plastic containers such as sweater boxes or small aquaria (may use clear glass 1 gallon jars or large glass or plastic bowls); 2 siphons- clear plastic tubing; 1 gallon of clear aged fresh water; 1 gallon of clear aged salt water (1 cup salt per gallon); 1 gallon of aged salt water (1 cup salt per gallon) with 8 drops of green food coloring; 1 gallon of aged fresh water with 8 drops of blue food coloring

Background

An estuary is defined as a semi-enclosed body of water where incoming water (salt or fresh) is diluted with fresh water coming from the land. Because of the differences in weight (density) between fresh and salt water, salt water will move upstream in the estuary along the bottom, while fresh water will flow downstream along the surface. This causes a layered condition. Some mixing occurs at the interface where fresh and salt water meet. The layered condition is said to be stratified. This activitiy illustrates such stratification.

Procedure

1. Before class, gather all the materials, make the saltwater solutions and label bottles. Aged water needs to be allowed to sit open at least overnight.
2. Ask the students what they believe happens when salt water meets fresh water. Where does this happen? Why?
3. Tell the students we can see what happens when a large body of salt water meets fresh water in a model saltwater estuary. Have students fill one container 1/3 full with clear aged fresh water. Then have a student slowly siphon in the colored salt-water solution, keeping the siphon tube near, but not on, the bottom of the container. What happens?

4. Have a student hold this container still while another student siphons clear salt water and colored fresh water in another container. There should be two stratified systems with the color on top in one and on the bottom in the other. This is most visible from the side.
5. How many layers are formed in each model? Which layer is salty? Which layer is fresh? Are they completely separate? Is something happening at the interface between the two layers? What? What would happen if we measured the salinity at differing depths from the surface to the bottom in an estuary?
6. Why did we do the experiment twice? The food coloring added a second variable. When it was used in the reverse order, we were able to demonstrate that this variable of food coloring was not the cause of the results.

Going Further

Have students record the results on data sheets. The sheets should have the students state the questions they are trying to answer through observation; draw the results of the demonstration; and make predictions on where they would find the saltiest water in an estuary and why.

Two H's and an O

Section II - The Hydrologic Cycle

The Never-Ending Cycle of Water

Primary Source

U.S. Environmental Protection Agency. (1991). *Always a river: Supplemental environmental education curriculum on the Ohio River and water, grades K-12* (pp. 91-92). Washington, DC: Environmental Protection Agency.

Teaching Outcomes

Students will visualize the phases of the water cycle and observe how water changes its state of matter.

Materials

A clear 2-liter soda bottle with a black bottom base for each student. One bag each of gravel, peat moss, and potting soil. Two types of plants for each student.

Background

Nature recycles the earth's water supply through a process known as the hydrological cycle. This is a continuous process that receives its energy from the sun. The plants take up the water through their roots and release it through their leaves (transpiration). The water molecules will condense on the plastic (condensation) and fall back into the soil like rain (precipitation). The plants will use the moisture in the soil for photosynthesis. Some water molecules will be evaporated by the sun.

This activity allows students to create a model biosphere (terrarium) to observe a water cycle and compare it to that of the earth's hydrologic cycle.

Procedure

1. Remove the black base and cut the stem off of the 2-liter soda bottle. Invert the clear plastic bottle and it will fit snugly into the black base.
2. Cover the bottom of the base with one inch of gravel for drainage. Add a layer of peat moss and then a layer of soil over the gravel.
3. Make two small holes in the soil and place the plants in so that the roots may be covered. Pack the soil around the plants without crowding them. Rocks, shells, or bark are examples of items that could be added for decoration.
4. Water the terrarium lightly and cover with the inverted plastic soda bottle. Place the terrarium in a sunny location and add 1 or 2 teaspoons of water a month.

5. Have students make daily observations of the terrarium. Discuss where the moisture on the sides of the plastic comes from.

   What provided the energy for the changes observed in the water's form?

   Does the student's biosphere compare to the earth's hydrologic cycle?

   What would happen to the terrariums if the plastic covers were removed?

   Can the students think of examples of the water cycle at work in their daily lives? (An example may be an icy glass of water on a warm day.)

Going Further

Fill a kettle half full of water. Heat the water with a hot plate. When the water boils, steam will come from the spout. Hold a metal tray of ice cubes over the steam and place another tray beneath this one. When the steam hits the tray of ice cubes, condensation will form. The water vapor being cooled as it hits the tray will form liquid droplets and fall. Discuss the concept of condensation.

Precipitation

Story of a Storm

Primary Sources

Carson City/Storey County Cooperative Extension. *Cscape in-school curriculum* (pp. 11-12). Carson City, NV: U.S. Department of Agriculture, Extension Service. (ent 90 EWOI-1-9234)

Southern Arizona Water Resources Association. (1984). *A sense of water: Teaching materials for elementary grades*. Tucson, AZ: Southern Arizona Water Resources Association.

SAWARA

Teaching Outcomes

All living things are dependent upon water to maintain life.

Materials

cardboard box
"rain situation" slips of paper.

Background

Throughout history, many societies have shown a dependence on rainfall for life. The Hohokam, an ancient Native American tribe, were a desert people who showed many adaptations for living in a desert environment. These adaptations included growing crops which could survive a certain amount of drought, and an effective rainfall harvesting system. Their dependence on the rain was also reflected in their religious beliefs through special rites and rituals that were performed to please their "Rain Gods."

Procedure

1. Prepare "Rain Situation" slips before class. Suggestions are listed below.
2. Have the students brainstorm the possible ways that water affects, or is a part of their daily lives.
3. Tie the Hohokam culture into the discussion. What did water/ rain mean to their culture? These people were noted for their adaptations to a dry environment. Have we also been required to make some adaptations to our environment with respect to water needs? List examples of possible adaptations.
4. Divide students into small groups. Each group picks a slip of paper and takes 5-10 minutes to prepare a short skit. The students can then present the skit to the class.

5. Throughout the skits, the main theme suggests that rain is essential for life. Refer to the list the students made of how water is a part of their lives. Are there any additions to be made?
6. The Hohokam eventually disappeared because of a long drought. List some effects for people today if water were not as plentiful. Is it possible that what happened to the Hohokam people could happen to our culture?

Suggestions for the Rain Situations:

1. You are kit foxes in the desert and have been without rain for three months.
2. You are responsible for your tribe's food and must depend on the summer rains for the crops to grow and provide your winter food.
3. You are the religious leaders of your tribe and must put on a ceremony for the whole tribe that will bring needed rain.
4. You had been waiting many months for rain and now it has come and you want to show your appreciation.

Precipitation

Water from the Air

Primary Source

Carson City/Storey County Cooperative Extension. *Cscape in-school curriculum.* Carson City, NV: U.S. Department of Agriculture, Extension Service. (ent 90 EWOI-1-9234)

Teaching Outcomes

To demonstrate an example of condensation.

Materials

a jar with a lid
ice cubes
paper towels

Background

Condensation is the cooling of water vapor until it becomes a liquid. As the dew point is reached, the invisible water vapor forms tiny visible water droplets. These water droplets form together to form clouds, and eventually as they increase in size and weight, they fall as rain or some other form of precipitation.

Procedure

1. Put the ice cubes into the jar and cover it with the lid.
2. Dry off the outside of the jar with the paper towels.
3. Let the jar sit in a warm place.
4. Have students observe and note any changes with the jar. Did any changes occur? Why or why not?
5. If water appeared outside the jar, what eventually happens to the water? Could this be related to the earlier definition of condensation with cloud formation? How?
6. If the ice melts, will the condensation continue?
7. Would the experiment have the same results if the jar was placed in a cold place instead of a warm one? Why or why not?

Water Movement

What Is Groundwater?

Primary Source

East Michigan Environmental Action Council. (1989). *Groundwater quality protection in Oakland County: A sourcebook for teachers* (pp. 24-25). Birmingham, MI: East Michigan Environmental Action Council. (ERIC Document Reproduction Service No. ED 257 685)

Teaching Outcomes

Students will understand the concepts of groundwater and water table.

Materials

2 clear plastic cups (4-6 oz.) (Fill one cup with pea gravel and fill the second cup half full of sand.)
water

Background

Groundwater is defined as the water found within the saturated pores of the ground. The water table is the area of line dividing the saturated soils from the unsaturated soils. This activity allows the students to create two models which illustrate these concepts.

Procedure

A. Groundwater

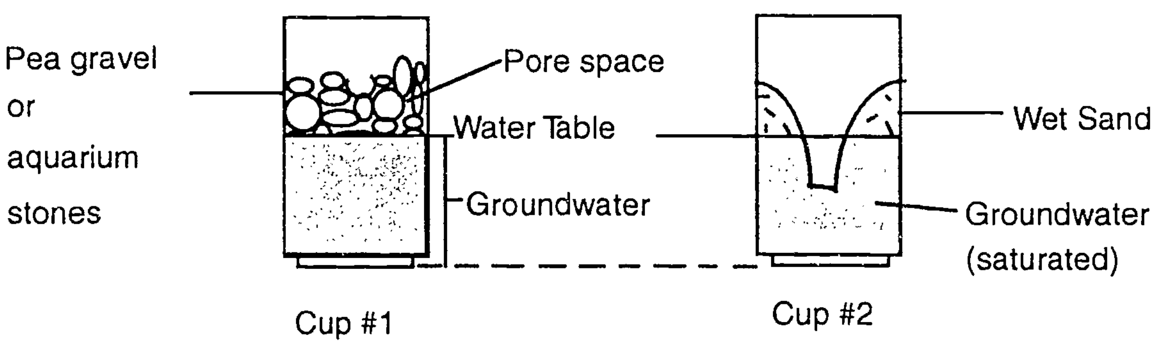
1. Begin by adding 2/3 of a cup of water to the pea gravel cup. Since this cup was full of gravel, where did the water go? If the pieces of stone represent soil particles, ask the students how is the groundwater represented? Have the students mark the water table line on the cup with a colored marker or tape.

B. Water Table

1. Using the cup half full of sand, explain that the sand represents soils under the ground. Add enough water to cover 2/3 of the soils. Have students observe the level of soils (sand) as water is added. Did the level change? Where is the water flowing?

2. Poke a hole into the sand with a finger. What happens when you put your finger into the sand? This hole represents a miniature lake. How does this relate to the definition of water table?

3. Ask the students if any of them have been to a beach and dug in the sand near the water. What happens as they continue to dig? How does this relate to the definitions of groundwater and water table line?



Water Movement

Water Infiltration in Soils

Primary Source

East Michigan Environmental Action Council. (1989). *Groundwater quality protection in Oakland County: A sourcebook for teachers* (pp. 26-27). Birmingham, MI: East Michigan Environmental Action Council. (ERIC Document Reproduction Service No. ED 257 685)

Teaching Outcomes

This activity illustrates how water moves through various soils (especially clay and sand) at different rates.

Materials

4 clear plastic cups
4 pencils
2 screen materials (such as: pieces of nylon stocking, paper towel, or coffee filter) for the bottom of the cups
dry clay soil
sand
water

Background

Water, and the particles it carries, moves through different soils at different rates. Sandy soils have larger particles and allow water to seep through more quickly than clay soils which serve as a barrier to water movement and contaminants.

Procedure

This activity is done by using two similar set-ups, one using sandy soil and one with clay soil.

1. Drill small holes in the bottoms of two of the plastic cups. The holes should be large enough to let water run out freely. Set each of the cups with holes over another empty cup, using two pencils as supports.
2. Place the screen material in the bottom of each cup with holes and then fill the cup 1/3 full with soil. (One cup should have clay soil, the other will be sandy soil.) Gently tap the containers to settle the soil, but do not pack them tightly.
3. Measure 1/2 cup water and pour into each of the two top cups.

4. Set the cups aside for 1/2 hour. At the end of the 1/2 hour, measure the amount of water in the bottom of each cup. Record.
5. Wait another 1/2 hour and repeat the measurement.
6. Was there a difference in the measurements taken from the sandy soil verses the clay soil? Why or why not? Did all of the water which was added to the soil drip out? If not, why?
7. How does this experiment compare with the student's knowledge of groundwater and water cycle? What are the implications for groundwater recharge?
8. If an accidental chemical spill occurred in an area with sandy soils, would there be a potential for groundwater contamination? If the same spill occurred in an area of clay soils, would you expect to see any difference? Are there other factors, besides soil types, which influence the likelihood of groundwater contamination occurring?

Going Further

A demonstration of soil infiltration may also be done out-of-doors using coffee cans with the tops and bottoms removed. Push the cans halfway into the soil. Pour a known volume of water into the can. Record the length of time needed for the water to penetrate the soil. Compare the results among various soil sites and discuss the results.

Water Movement

How Wells Work

Primary Source
Cedar Creek Learning Center in Cooperation with the Tennessee Valley Authority. (1986). *Groundwater: A vital resource.* Knoxville, TN: Tennessee Valley Authority.

Teaching Outcomes
This activity will help students better understand about the water table and how a well works.

Materials
a glass
pencil
fine wire screening
small wire (for fastening)
medicine dropper
coarse sand
water

Background Information

The water table is the top surface of the saturated zone. The water table separates the saturated zone from the unsaturated zone. The saturated zone is where the ground water is.

This activity helps students understand how wells connect with the water table.

Procedure

1. Have students role a piece of screening around a pencil to make a cylinder.
2. Enlarge the cylinder so it is about 1/2 inch in diameter and fasten with a piece of wire to keep it from unrolling.
3. Place the cylinder upright in the glass. Fill the glass with sand keeping the sand out of the cylinder.
4. Pour water into the sand. The sand represents the soil and takes up water, but water also goes into the cylinder...the well.
5. Using the medicine dropper, remove water from the well. What happens? Add water to the soil. What happens?

Going Further

Many rural people rely on their own wells as their water source. Year after year, some farmers apply insecticides/herbicides to their land for increased productivity. Talk about how pollutants, ground water, and the health of individuals in that community might be connected.

Transpiration

Where Transpiration Occurs

Primary Source

University of Vermont Extension Service. (1990). *The water around us*. Burlington, VT: UVM Extension. (C 90-1)

Teaching Outcomes

This demonstration will show where most of the transpiration of leaves occurs.

Materials

6-8 fresh green leaves
petroleum jelly

Background

Transpiration is the part of the hydrologic cycle which involves releasing water vapor into the air. As the roots of plants collect water from the soil, the stem passes the water up to the leaves where transpiration occurs. This activity allows students to explore more specifically which part of the leaves are active in transpiration.

Procedure

1. Divide the leaves into two groups.
2. Apply petroleum jelly to the underside of one group of leaves and then apply the jelly to the upper side of the remaining group of leaves.
3 Expose all of the leaves to the classroom air and have the students observe and record any changes in the leaves over a period of time.
4. Did one group of leaves wilt any quicker than the other? Why? What was the function of the petroleum jelly? What part of the leaf is actually involved in transpiration? What led you to this conclusion?

Transpiration

The Role of Leaves in the Water Cycle

Primary Source

Carson City/Storey County Cooperative Extension. *Cscape in-school curriculum* (p. 22). Carson City, NV: U.S. Department of Agriculture, Extension Service. (ent 90 EWOI-1-9234)

Teaching Outcomes

This activity allows students to follow the water cycle through transpiration to develop an understanding of how the water vapor goes into the air and forms clouds.

Materials

3 bottles with water
3 branches (One branch should be without leaves, one with few leaves, and one with many leaves.)

Background

Transpiration is a process in which plants send water vapor into the atmosphere. The roots absorb water from the soil and send it through the stem to the leaves. It evaporates into the air from the surface of the leaves. Once the vapor is in the air, it can rise to form clouds and eventually form rain or snow.

Procedure

1. Fill the three bottles with equal amounts of water.
2. Place one of the branches in each bottle.
3. Have the students observe the bottles for several days and record any changes in the amount of water in each bottle.
4. Is the water level changing at the same rate for each bottle? What could explain any possible differences in the rates of the changing water levels? What has happened to the water that has disappeared? How does this relate to the hydrologic cycle of the earth?

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Going Further

Using the above activity, ask the students to construct a way to collect the water that has transpired. How could this water be used to benefit the plant in the future?

Transpiration

Survival Still

Primary Source

Carson City/Storey County Cooperative Extension. *Cscape in-school curriculum* (pp. 54-55). Carson City, NV: U.S. Department of Agriculture, Extension Service. (ent 90 EWOI-1-9234)

Teaching Outcomes

By learning an outdoor survival technique, students will both observe and benefit from transpiration.

Materials

a trowel or digging utensil
coffee can
thin plastic sheet (1 yd. square)
leafy shrubs
stones

Background

Safe drinking water is necessary to survival. Basic knowledge of the hydrologic cycle, specifically transpiration (where plants and soils release water vapor), could be the key to staying alive!

This activity challenges students to use their knowledge of transpiration. They will use soil and leafy plants in their area to create a still and produce safe drinking water.

Procedure

1. Have students choose a sunny spot and dig a hole 30 inches square and 18 inches deep.
2. Place the coffee can container in the center of the hole.
3. Surround the container with lots of leafy shrubs.
4. Place the plastic sheet loosely over the hole. Place stones around the edges to secure the sheet in place.
5. Put a small stone in the center of the sheet so that the plastic will sag toward the container.

6. Observe the still over a period of time, overnight if possible. Has any water been collected? If so, have the students taste it! Where did the water come from? How would the amount of sun or leafy shrubs affect the amount of water collected? How does this survival technique relate to the hydrologic cycle?
7. When the students are finished with the still, be sure to replace all the soil. Challenge the students to think of other examples of how they could use basic principles of nature to aid in survival.

Going Further

Place a clear plastic bag over a recently watered houseplant. Tuck or tie the mouth of the bag beneath the pot. Observe and record the number of hours before moisture collects on the inside surface of the plastic. What happens to these drops? Is it possible to have a self-watering plant?

Evaporation

Vanishing Breath

Primary Source

U.S. Environmental Protection Agency. (1991). *Always a river: Supplemental environmental education curriculum on the Ohio River and water, grades K-12* (p. 93). Washington, DC: Environmental Protection Agency.

Teaching Outcomes

As students experience water changing from liquid to vapor, they will identify the process of evaporation.

Materials

a blackboard
chalk
1 student

Background

Evaporation is the process of returning moisture to the atmosphere. This activity allows students to quickly produce moisture and observe as it evaporates.

Procedure

1. Have a student exhale close to the blackboard to form a dark spot.
2. Trace the spot with chalk. Why is the spot darker than the rest of the board?
3. Fan the spot so it disappears. Why did it disappear? Where did the moisture go?
4. What if, instead of fanning the spot, a towel was used to wipe the spot dry. Would evaporation still be occurring?
5. Each day, we encounter the process of evaporation many times. Ask the students to list as many examples of evaporation as they can think of.

Going Further

Ask all the students to wash their hands, but not to dry them with a towel or their clothes. Have them (carefully) wave their hands in the air and announce when their hands are completely dry. How long did it take? Did all hands dry at the same time? Why or why not? Would they dry faster in hot or cold weather? Humid or dry? Why? What has happened to all of the water?

Evaporation

Evaporation through Paint

Primary Source
U.S. Environmental Protection Agency. (1991). *Always a river: Supplemental environmental education curriculum on the Ohio River and water, grades K-12* (p. 93). Washington, DC: Environmental Protection Agency.

Teaching Outcomes
Students will identify how evaporation and the water cycle play a part in their daily activities.

Materials
paper
paint brushes
water color paints
a water supply

Background

Evaporation is the process of returning moisture to the air. It is a process which many people rely on to complete even simple daily tasks. This activity involves the students in a common act of painting a picture. However, in order to complete the picture, evaporation must occur.

Procedure
1. Pass out the paints, brushes, paper, and water to each student.
2. Ask the students to paint a picture (possibly one of a nearby river habitat) or design a symbol of what water means to them.
3. Set the paintings aside. Is anything happening to the paintings while they are being set aside?
4. When the pictures are dry, ask the students to explain where the water went. If the students painted a picture of a river scene, ask them to discuss how evaporation affects the life found in that picture.
5. What other activities during their day depend on the process of evaporation occurring?

Evaporation

Puddle Wonders!

Primary Source
Project WILD. (1987). *Project WILD aquatic education activity guide* (pp. 21-24). Western Regional Environmental Education Council

Teaching Outcomes
By calculating the area of surface water (puddle), students can observe the rate of evaporation.

Materials
pencils
papers (data sheets)
rulers
string for each student

Background

Included in the hydrologic cycle is the process of evaporation. This is shown when surface waters on the earth, especially mudholes, ponds, streams, rivers, lakes, and oceans, are warmed by the sun's heat until becoming water vapor and rising into the atmosphere.

This activity asks the students to measure a fresh puddle and continue observing and measuring it to determine the rate of evaporation.

Procedure

1. Divide the students into groups of two and take them to an area with puddles available. Try to chose a remote area of a parking lot or other paved area (out of the travel zone). Each team should choose a puddle.
2. Using the string and rulers provided, have the students measure the radius if the puddle is somewhat circular, or find the average width and length. These measurements will help the students to calculate the area of the puddle.

   Helpful Information:

   Area=Pr^2 OR

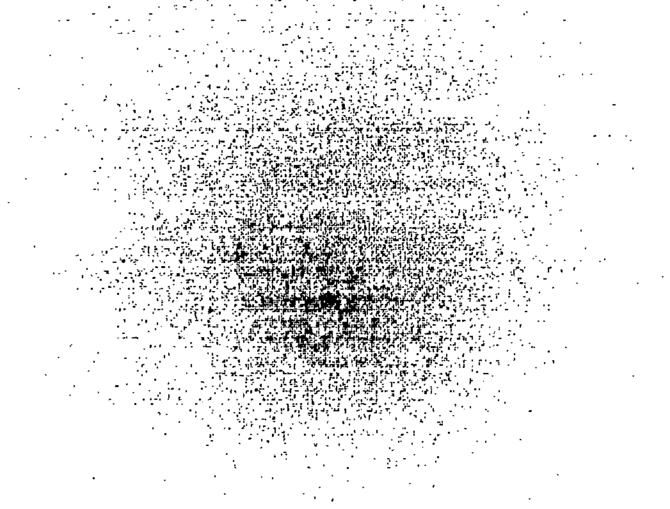
   Area=Average Length x Average Width

3. Repeat the activity the next day, or next several days, using the same groups of students with their same puddles.
4. Does the area of the puddles remain the same each day it is calculated? What factors could affect this calculation? As the area increases or decreases with each measurement, what aspects of the hydrologic cycle are being observed?
5. Wet feet are often a result when walking across a grassy area in the morning. However, it is possible to have dry feet when walking the same area in the afternoon. Why? How does evaporation and transpiration relate to this situation?

Going Further

More water is lost by evaporation from the oceans than is gained by precipitation over the oceans, yet the oceans remain full. How is this deficit made up?

Two H's and an O



Section III - Using Water

Water Needs

Our Changing and Growing Need for Water

Primary Source

Massachusetts Water Resources Authority. (1987). *Water wizards: school program on water conservation for third and fourth grade levels* (p.20-21). Boston, MA: Massachusetts Water Resources Authority. (ERIC Document Reproduction Service No. ED 313 263)

Teaching Outcomes

Students will demonstrate the effects of development on the water supply and how the need for water has increased over the years.

Materials

clear plastic box
straws, pipettes, or eyedroppers (one for each student)
water
art supplies such as paper crayons or paints

Background

Water use increases disproportionately to population density. How is this so and why is this so? This activity sculptures a mini-history of an area to clarify and exemplify this concept. In the real world, there is replenishment of water through natural precipitation and water movement. This is not taken into account in this activity, but could provide a valuable discussion to follow.

Procedure

1. Have students draw a mini-mural of a cross section of the Earth's surface. Tape the mural to the top half of the side of the clear plastic box and partically fill the lower half with water. Mark the level of the water. Cover the top of the box with paper.
2. Tell the students it is 1800. Four farm families live in a small valley. A new farming family of eight arrives in the valley with 2 horses and 3 cows. Why do they need water? The five farm families have dug wells. There has been lots of rain and the wells are full of clean water. Add 1 cup of water to the box.
3. Have students "drill" 5 wells with straws or eyedroppers through the paper into the box. Have them take sips of water to represent water use. Mark the water level. Write a story about a day in the life of this community— washing, chores, and other factors of life.

4. In 1850, ten more families move to the valley and bring many flocks of sheep. Drill 20 more wells, sip (or draw) some water and mark the new water level.
5. By 1900, fifteen families have moved in. A small hotel and two schools are built. For five years there has been less rain than usual. What has happened to the level of water in the wells? The water table? Some farm houses now have a hand pump at the kitchen sink. This lifts water from the well in a single pipe. Wastewater drains outdoors onto ground into a ditch. One farmer brought a washing machine with a big paddle to push by hand. The privy has been built in the shed by the barn. Some wells have gone dry and new ones dug at a distance. Drill 15 more holes, take sips (or draw) of water, and mark the water level again.
6. By 1950, most homes have a bathroom with a tub and flush toilet and an electric washing machine. There is a car wash in the village. A new industrial plant is built and sends waste into a small stream. Only two old wells are still in use as the others are polluted. The town has built a water system that connects every house by pipes with the local reservoir. Today, every person uses at least 60 gallons of water per day. Take more sips (or draw) of water.
7. Why didn't people in 1800 use as much water as those in 1950? How did some communities solve the problem of having enough water?

Going Further

Reflect back on the hydrologic cycle. How does water that can be accessed by people for human consumption replenished or reintroduced? In the model, how could we do this? How might we be able to determine a natural rate of precipation for this area? What difference would the rate of precipation make?

Water Needs

Water Quality; Quality of Life

Primary Source

Wisconsin Department of Public Instruction. *Pollution: Problems, projects and mathematical exercises, Grades 6-9*. Madison, WI: Wisconsin Department of Public Instruction. (ERIC Document Reproduction Service No. ED 046 746)

Teaching Outcomes

Students will become aware of the amount of water used by various sectors of society by calculating average water uses.

Materials

paper
writing implements

Procedure

1. To meet overall needs of the average community, a water utility must supply 150 gallons of clean water per person each day. Use the population of your community to compute the amount of water that must be produced by the water utility each day; each week; each month; each year.
2. For residential purposes, the average American uses 60 gallons of water each day. As an average American, how much water would you use in a week?
3. Commercial operations use about 20 gallons of water per day per person. How many days of commercial operation are needed to use 600 gallons of water per person?
4. About 10 gallons of water per day per person are lost through breaks in pipelines. In one year, how much water is lost with no benefit to the people in your community? How many days of average water use is that?

5. If each day a 2-year-old steer weighing 700 pounds drinks 12 gallons of water, how many gallons will be required to water 1000 of these steers in a day?
6. If it requires 1,400 gallons of water to produce a dollar's worth of steel, how many gallons would be used to produce $50 worth of steel?
7. Industry uses on the average 50 gallons of clean water per day per person from the public system. It takes about 500 gallons of water to produce one gallon of gasoline. If all of industry's water per day was used to produce gasoline, then how many gallons of gasoline could be produced in a community of 50,000 people?
8. The paper industry needs about 90,000 gallons of water for each ton of paperboard produced. How many gallons of water does it take to produce one pound of paperboard? If 53 million tons of paperboard are produced each year by the paper industry, then how many gallons of water would be used each year?
9. What are ways in which we can reduce the average daily use of water?

Water from the Environment

Water Condensers

Primary Source

Nebraska Cooperative Extension Service. (1988). *Water riches: Teacher's guide* (pp. 12-13). Lincoln, NE: Nebraska Cooperative Extension Service.

Teaching Outcomes

Students will discover how to condense water from soil using a still.

Materials

- several sheets of plastic of various colors and sizes—one sheet per experiment
- 1 rock or weight for each plastic sheet
- 1 can for each plastic sheet
- weighty materials to raise ends of plastic and hold plastic in place
- shovel

Background

Water is held in soils of all types. We can draw the water out of the soil the same way nature does through evaporation and then we can condense the water to capture it as a liquid. We do this through a condenser or still. In the experiment, the darker plastic heats the soil during the day. At night, the temperature of the plastic drops faster than the soil temperature, causing moisture to condense on the plastic. The slope of the plastic will cause the droplets to flow into the can. Black plastic and moist soil will work best. Experiments can be simulated indoors using heat lamps for sunshine if the air can get cool enough at night to contrast with the heat. The soil should be damp to the touch.

Procedure

1. Divide students into as many groups as you have types of plastic. Give each group a type of plastic and a can. Outdoors, have students dig a small pit in the ground that is wider and deeper than the can. You will need one small pit for each type of plastic sheeting. Slope the surrounding soil toward the pit so the plastic doesn't sit directory on the level of the ground. Place the can in the bottom of the pit.
2. Have each group cover its pit with the plastic, securing the ends to suspend the plastic over the slope of the pit. Place a rock directly in the center of the plastic over the can.
3. Evaporation takes place because of the sun's heat. This experiment will work best if it is done over a period of time when the temperature changes considerably. Overnight is best. At various times, have the students "peek" into their stills. What is happening?

4. At the end of the experiment period, what is in the can? Where did it come from? How did it get there?
5. What would happen with different types of soil? In different weather? Can the class construct experiments that will test their hypotheses?

Water as a Resource

Producing Energy from Water

Primary Source

Tierney, B. (1984). *Energy activities for the primary classroom* (p.40-41). Sacramento, CA: California Energy Extension Service. (ERIC Document Reproduction Service No. ED 249 082)

Teaching Outcomes

Students will discover the ways that energy can be captured from water.

Materials

A: Cork; cardboard; pins
B: 6 egg cups from a foam egg container; two disks cut from cardboard (about eight inches diameter); stapler; small dowel rod; string
C: 16 ounce juice can with ends in place; lid from another 16 ounce juice can; finishing nail; strip of bendable metal about two inches wide; heat source such as sterno stove, bunsen burner, etc.; water; duct tape or epoxy glue

Background

Water is a renewable resource that is an important source of electricity. The potential energy of water is harnessed to produce mechanical energy which can be used directly or used to generate electricity. This is done by capturing the power of moving water (hydroenergy) or by using steam from heating water to turn turbines.

Procedure

A: Moving Water - Moving Blades

1. Have students cut cardboard strips the length of the cork. Tape the strips onto the cork and put pins in the ends of the cork for axles. Using another piece of cardboard, make a U-shaped holder for the water wheel.

2. Metal or plastic fins can be placed into slits cut in cork as an alternative.

3. Hold the water wheel under a source of running water. What makes the wheel go faster or slower? What does this suggest about energy in moving water?

B: An Overshot Waterwheel

1. Discuss the old waterwheels used for grinding grain or running machines. Great power and slow speed were needed to turn the heavy grinding stones at an even speed. This device could use a relatively small stream, as it is the weight of the water in the buckets that causes the wheel to overbalance and turn.

2. Have students cut six egg cups from a foam egg carton and two eight inch round disks from cardboard. Staple the egg cups to one side of one disk so that they are evenly spaced along the circumference of the disk all facing in the same direction. Staple the other disk to the other side of the egg cups so that the cups are enclosed between the disks.

3. Punch a hole in the center of the two disks and slide the dowel through the holes. Hold the ends of the dowel and place the water wheel under a source of running water. If you wish, tie a string onto one side of the disks and see what type of weight the water wheel can lift.

C: Power Plant from a Juice Can

1. Since heat is on a microscopic level, the motion of molecules, it makes sense that the motion can be transformed to work for humans. By making a boiler out of a metal juice can, we produce steam which will turn a turbine. Falling water can also turn a turbine in a hydro-electric plant.

2. Make two holes in a 16 ounce juice can and drain and save the juice. Rinse the can.

3. Take the lid from another can and cut small slits along the edge with tinsnips. Twist each tab in the same direction to form a propeller.

4. Put a hole in the center of the propeller to form an axis. Make a mount out of a scrap of metal so that the blade may spin feely on a finishing nail. Mount this to the top of the can with duct tape or epoxy glue. The blade should be directly over one of the holes in the "boiler." The other hole should be plugged with a screw or stick after the boiler is 1/3 filled with water.

5. Heat the boiler using a fresnel lens, large focusing collector, sterno stover, bunsen burner, etc. Avoid touching steam and the can as they can burn easily. What happens. What can we do with this?

Going Further

Relate this activity to existing energy production in your geographic area. Some students may be interested in looking at historical means of energy production. Compare to this model.

Water as a Resource

What If Water Cost as Much as Gasoline?

Primary Source

Vine, V. (1981). *Local watershed problem studies: Elementary school curricula* (p. 100-101). Madison, WI: Water Resources Center.

Teaching Outcomes

Students will compare the reasons people conserve energy with reasons people conserve water. Students will take a "trip" into the future when a gallon of water costs as much as a gallon of gasoline.

Materials

Play money in various denominations (or make some 5 and 10 dollar bills)

Background

Historically, energy has been cheap enough that people have not conserved carefully. People drove as much as they desired, kept homes very warm and did little to insulate. Few people had insulation in the walls or attics of homes and weather stripping was not common.

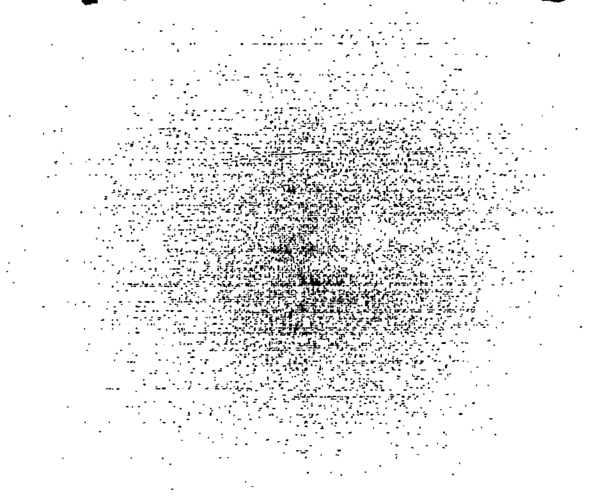
Today, water is relatively inexpensive. Few people try to conserve water, just as few conserved gasoline or fuel oil when it was cheap.

Procedure

1. What is the lowest price any of the students remembers paying for a gallon of gasoline? What is the price now? Do students' families try to conserve gasoline use? How?
2. What would have been the families' responses if they had known in the 1960s what gas prices would have been in the 1990s? Is this the same for heating homes? Have students talk to their families about rising heating costs.
3. How much does the water used in students' homes cost each year? How could they find out? Do they try to conserve water? Why or why not? Which do families work harder to conserve, energy or water? Why?

4. Have students imagine that they are taking a trip into the future when a gallon of water costs the same as the current price for a gallon of gasoline. On the weekend, they will have to "purchase" all water used by placing the correct amount of money in an envelope.
5. Since some people have more money than others, give a few students $30 (a very tight water budget), some students $40 (a moderate water budget) and a few students $80 (the wealthy).
6. Have students brainstorm a list of ways they use water. Write the ideas on the chalkboard. Using various sources such as the library, local or state agencies such as the EPA, etc., have students find out how much water it takes for each use (such as flushing toilets, taking showers, brushing teeth, washing cars or clothes, etc.).
7. Each student is then to determine how to spend the given water budget. How do they decide what water uses are priority? Are the priorities the same for everyone? What if the budget is for two or three individuals, rather than one? What activities conserve their budget? Can they buy from each other?
8. Allow time for open trade and planning. Then, if desired, add variables, such as a drought or extra rainfall; a water use tax; low flush versus standard toilets, etc. Process the activity with the students. What happened? Why? What does this suggest about the real issues of water availability?

Two H's and an O



Section IV - Water Conservation

Water Conservation

A Water Plan of Action

Primary Source

Vine, V. (1981). *Local watershed problem studies: Elementary school curricula* (p. 90). Madison, WI: Water Resources Center.

Teaching Outcomes

Students use role playing and language skills to express solutions to inefficient water use for the country.

Materials

pen and paper for each student

Background

Water waste and conservation are major issues facing the country and the world. The availability of drinking water for each individual could affect that person's approach to the overall problem. When faced with a loss of fresh water, one is forced to identify water waste situations and their solutions.

This activity requires the students to take the role of the President and use their critical thinking skills to formulate a plan for the country when faced with a serious water shortage.

Procedure

1. Have each student make a list of all the possible uses for water. Then, prioritize the water uses from most to least important according to their personal needs. Compare lists with other students. How do you think your list might compare to the list of someone living in another part of the country?
2. After discussing the lists, place the students in the following situation: Each student will become the President of the country during a serious shortage of clean water. The students should write an essay describing their plan of action. The essays should include the positive and negative aspects of the plan, as well as the reasons that it will work.
3. After writing the essays, the students need to "sell" the class on their plan. They should explain why it would work and answer other student's questions - especially from those who believe that they have a better plan.

Leaky Faucet

Primary Source

Project I-C-E. *Environmental education guide: Grade two.* Green Bay, WI: (ERIC Document Reproduction Service No. ED 100 654)

Teaching Outcomes

Students will understand how one leaky faucet can equal a large volume of wasted water.

Materials

1 dripping faucet
1 measuring cup

Background

For many, the availability of water is taken for granted. Therefore, an isolated occurrance of a dripping faucet may not be a problem. However, within one hour, a dripping faucet can produce a measurable amount of clean, usable water. This volume, multiplied by 24 hours or several days, creates an alarming statistic of wasted water.

This activity allows students to measure the water wasted in one hour from a dripping faucet. The students can use that information to understand how much water they may be wasting during a given time.

Procedure

1. Using the measuring cup, collect the water from a dripping faucet for one hour.
2. Have the students multiply this figure by 24 hours and then by 7 days.
3. Ask the students to investigate how many dripping faucets they can find in the school.
4. Assuming that each faucet drips the same rate as the original faucet measured, find the total volume of water wasted in the school for one day.
5. Have the students list how many times and for what purposes they use water each day. Where does their water come from? What happens to the water when it runs down the drain?

6. Ask students to list all sources of water that they are aware of. Separate the list into drinking water sources and nondrinking water sources. What determines whether water is safe to be used as drinking water? What is done within your community to insure that you have safe drinking water?

Going Further

1. Have the students measure how much water each of them uses in one 24 hour period. Was any of that water usage unnecessary? How would their daily lives change if they were only allowed to use half the volume of water which they previously used?
2. Instruct the students on how to read a water meter. Have the students go home and pick a time when no one will be home or using any water. Before everyone leaves, have the student read the water meter and write down its setting. When everyone returns home, the student should read the meter again. If the numbers have changed, then a leak may have been detected.

Off and On

Primary Source

Coon, & Price. (1977). *Water-related teaching activities*. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 150 026)

Teaching Outcomes

Develop an awareness in students that simple daily activities play a major role in water waste management and conservation.

Materials

an empty container or bowl marked at various levels such as 1 liter, 2 liters, 1 gallon, etc.
stopwatch
water source

Background

Easy accessibility to water is a luxury many people rely on. Life would be much different if water first had to be pumped by hand and then hauled to its destination. It is amazing how much and how quickly water is accessible just by turning on a faucet. It takes about 30 gallons of water to do a load of laundry; 300 gallons of water to grow the wheat for one loaf of bread; and 40,000 gallons of water to make the steel for one car! Up to 20,000 gallons of water per year per person could be saved if everyone would remember not to let the water run needlessly.

This activity has students discover how much water flows through various faucets in a specified time, and how that potentially wasted water could otherwise be used.

Procedure

1. Ask how many students prefer a very cold drink of water to a room temperature drink? How long does it take to get the water nice and cold before taking a drink? How much water do they think will come out of the sink in one minute?
2. Have the students identify two or three water sources (drinking fountains; restrooms; etc.). At the first source have one student hold the empty container under the faucet. Prepare another student with the stop watch to time the activity.
3. Turn on the faucet and begin the stop watch. Have a "watcher" call out when the water reaches the various marks. Have another student record the times.

4. How long did it take to fill the container? Which water source was fastest? Slowest? Why? How long would it take for running water from a kitchen sink to get cold? List other common activities in which people often let the water run needlessly. How many uses can the students think of for the water currently in the container?

Going Further

Hold a toothbrushing contest! Determine who (the teacher or the student) can use the least amount of water while brushing their teeth. Many people have developed the habit of leaving the water running while brushing. By not doing this, up to 9 gallons of water could be saved each times a person brushes! What are other habits that are water wasteful?

Raining Showers

Teaching Outcomes

Students will identify water waste situations in their homes.

Materials

empty waxboard (milk) container
stopwatch
standard working shower-head
measuring cup(s)

Background

An average shower uses 5 gallons of water per minute. This easily equals 25 gallons of fresh, clean drinking water per shower! Low flow shower heads are one solution for water conservation. They add air to the water which reduces the volume of shower water to half the previous amount. Another option is to turn off the shower while "soaping" and shampooing. Some places are even using rainwater for showers, rather than tapwater.

Procedure

1. Ask the students to time their next shower and bring that information to class. List the students' shower times and find the average length. By making educated guesses, have the students list how much water they believe they might have used for their shower.
2. Take the students to a shower head in the school (possibly in the gym showers). Turn on the shower to a normal flow. Ask a volunteer to hold the container up to the shower head. Another student, by using the stopwatch, will start and stop the time. The first student should collect water for a total of 10 seconds.
3. Measure the amount of water using the measuring cup. How much water was collected in 10 seconds? How much water is that in one minute? Using the average shower length figured for the class, how much water would be used for a whole shower using this shower head? Is this amount close to any of the student guesses made in procedure 1 concerning how much water they believe they may be using per shower?

Going Further

Give each student an empty half-gallon milk container and ask them to repeat the previous activity with a shower head at home. If the container overflows in less than 10 seconds, list all the advantages their family would have by switching to a low-flow shower head.

Make It a Royal Flush

Primary Source

The Earth Works Group. (1989). *50 simple things you can do to save the earth* (pp. 48-49). Berkley, CA: Earthworks Press.

Teaching Outcomes

Students will realize that there are simple techniques they can utilize to conserve water at home and at school.

Materials

several small plastic bottles with caps (juice, dishwashing soap, and laundry soap bottles work well.)
several small stones
1 displacement bag
1 to 2 toilet dams could be used for demonstration

Background

Each time an average toilet is flushed, it uses 5-7 gallons of water. This could add up to 40% of the water used in a typical home. By using a simple displacement device in each toilet tank, the amount of water needed to flush could be reduced by15-40%.

Procedure

1. Ask the students to bring a copy of their family water bill to class. If toilets are said to use 40% of a home's water, ask the students to calculate how many gallons that equals in their home.
2. Divide the students into groups based on how many toilets/restrooms are available for use.
3. Have each group select a plastic bottle. (Be sure all labels been removed.) Fill the bottles with water and cap them.
4. Place each bottle into a tank. If necessary, add stones inside the bottles to weigh them down.
5. Compare the effectiveness of the various types of bottles used.

6. Bring the class together and demonstrate displacement bags and toilet dams as alternate water displacement tools. The bottles, bags, and dams are designed to save 1-2 gallons of water per flush.
7. Encourage students to implement similar devices in their home toilets.
8. The following month, ask the students to bring a copy of their family's latest water bill. Compare and note any changes from the previous bill. List any factors which could have influenced those changes. What effect, if any, did installing the water displacement devices have?
9. Water conservation is an especially important topic in certain regions due to a limited availability of drinking water. Place the students in such a setting and ask them to list their uses for water. Prioritize that list from most to least important and then decide how much water is necessary to meet each water need.

Going Further

Another factor affecting the amount of water used by a toilet would be discovering if the toilet is leaking. Have the students, either at home or at a school toilet, remove the cover from the tank. Add about 12 drops of red or blue food coloring to the tank. Wait about 15 minutes. Be sure no one uses the toilet during this time. Then look in the toilet. If colored water shows up in the bowl, you've found a leak!

A Lawnly Rain

Primary Sources

U. S. Environmental Protection Agency. (1991). *Always a river: Supplemental environmental education curriculum on the Ohio River and water, grades K-12.* Washington, DC: Environmental Protection Agency.

Coon & Price. (1977). *Water-related teaching activities.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 150 026)

Teaching Outcomes

Students identify how watering the lawn is a major source of water usage in communities and consider options for a healthy lawn without wasting water.

Materials

a sprinkler hooked up on school grounds

3 empty coffee cans marked with permanent marker 1 inch from the bottom

Background

During summertime, Americans use 1/3 more water than the rest of the year. Much of this increase is spent on watering lawns. Some people think that the more they water a lawn, the better it will grow. Most lawns are watered twice as much as is necessary. (Most lawns only need 1 inch of water per week.) Further, a fair amount of the water used goes onto driveways, sidewalks, and roads, not onto the grass!

This activity has students measure the time required for watering an area up to 1 inch deep. They will also compare absorption versus runoff.

Procedure

1. Ask the students to list all the yard and household chores which they, or their parents, do at home. Did caring for the lawn make the list? For many, a common water use involves watering the lawn. Ask the students to describe what is involved with watering the lawn.
2. Take the students, 3 cans, rulers, and the pencils and paper to the playground or where the sprinkler is set up.
3. Divide the students into 3 groups - one group for each can. Arrange the cans (groups) at different proximities to the sprinkler.
4. Turn on the sprinkler and have each group measure and record the time needed for each can to collect 1 inch of water.

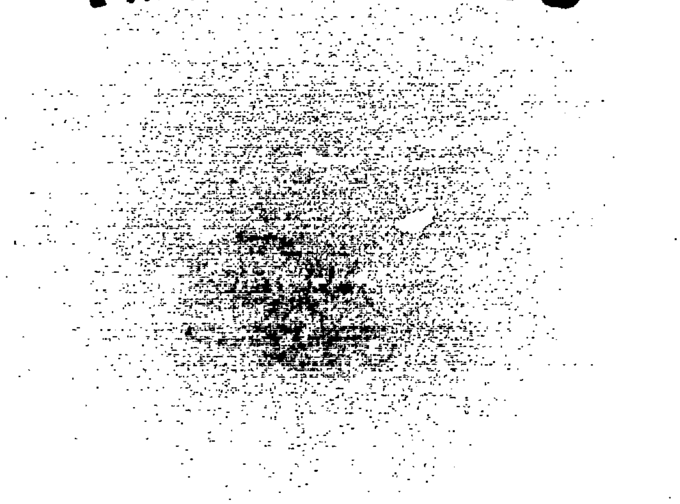
5. Bring the class together. Add the time results from each group together and divide by 3 to find the average length of time required to collect 1 inch of water. Another option would be to "test" the evenness of watering of various types of sprinklers.
6. Have the students research, call a lawn-care company, or call the water company, to find out how much water is required per week by most grass lawns in their area.
7. In addition to limiting the amount of water used, what other steps could be taken when sprinkling the lawn to conserve water without damaging the plant-life?

Going Further

Measure the blacktop or parking area around the school building in square feet. We can calculate the amount of water that would run off of the blacktop surface if we watered it for one inch. Since one gallon equals 231 cu. in., the calculation to determine gallons is: area in sq. ft. x 144 x amount of rainfall in inches or fraction thereof divided by 231. How often is the run-off equal to the daily needs of the class? What actually happens to the run-off water from the schoolyard? Does it ultimately become some city's water supply? Whose? Could we use this formula to calculate rainfall run-off?

During drought conditions, many communities restrict or ban people from watering their lawns. Using some information from the previous activity, calculate how much water could potentially be used in a month on a neighborhood block of lawns. Explain why some communities might restrict this use of water.

Two H's and an O



Section V - Water Pollution

Pollution

Movement of Groundwater and Contaminants

Primary Source

East Michigan Environmental Action Council. (1989). *Groundwater quality protection in Oakland County: A sourcebook for teachers* (pp. 20-26). Birmingham, MI: East Michigan Environmental Action Council. (ERIC Document Reproduction Service No. ED 257 685)

Teaching Outcomes

To create an understanding of movement of contaminants and to visually observe how contaminants move into soil

Materials

clear plastic shoe box with 1" layer of sand
high silica sand (building supply, aquarium sand, or grouting sand)
food coloring
powdered lemonade mix (with or without sugar)
sprinkling can or spray bottle
4 plastic straws, cut in half
acid-base indicator solution such as Bromocresol Green [optional]
wide range pH paper

Procedure

1. Prepare (or have students prepare) the box. Place one end of the box on a piece of wood so that it is about 1 inch higher than the other end. Layer the sand in the box so that it is no more than 1-2 inches deep over the blocked end and shallower on the lower end.
2. Discuss with the learners that some things that spill on the ground are "visible contaminants." Can they think of any? (oil is a good example). Have someone place about 5 or 6 drops of liquid food coloring on the surface of the sand next to the wall of the plastic box. The food coloring can represent a chemical contaminant.

3. Have another student make it "rain" on the contaminant, by using the spray bottle or sprinkler and water. The "rain" should be light, so that the food coloring is diluted and seeps into the sand without running off the top. It may take up to five minutes to move the food coloring to the bottom of the box where the plume of contamination will be visible. If wet sand is used, the contaminant will move more quickly.
4. Every two or three minutes, have the students check the bottom of the box for evidence of color. Have a student draw the shape of the plume on the chalkboard.
5. Check the size and shape of the plume after half an hour. Discuss the results.
6. The same process can be used to examine invisible contaminants in groundwater by preparing the box in the same manner. At the upper end of the box, have a student make a small depression in the sand and add 1 teaspoon of powdered lemonade (more powder will more speed up the demonstration). Cover the powder with sand. This is the contaminant.
7. Tape 12 one-inch pieces or one 10" long strip of pH paper to the top of a counter or desk.
8. "Rain" on the upper end of the box so that the sand gradually becomes saturated. As it rains, have the students discuss how they might be able to discover the movement of groundwater and the invisible contaminant. Probe until they consider taking similar measurements from different parts of the box. Using pieces of plastic straw, have students remove plugs of sand from different places in the box keeping track of which sample came from what part of the box. Drop the sand on the pH paper. If the paper color indicates a drop in pH, what does that mean? (more acidic— the contaminated groundwater has been found). Be sure a fresh or washed straw is used for each measurement.
9. Have the students draw a record of where the contaminant was found in the box. Take at least twelve samples. Discuss:

   What makes the contaminant travel away from the place where it was originally buried?

   Why did the contaminant move in that direction?

   What factors underground might influence the movement of contaminants?

   How many samples of sand would be needed to know exactly where the "plume of contamination" was located?

   If a real contamination site were discovered in your community, what would the scientists do to test for groundwater contamination?

Pollution

Stormwater Infiltration and Contamination Pathways

Primary Source

East Michigan Environmental Action Council. (1989). *Groundwater quality protection in Oakland County: A sourcebook for teachers* (p. 72). Birmingham, MI: East Michigan Environmental Action Council. (ERIC Document Reproduction Service No. ED 257 685)

Teaching Outcomes

Students will explore the ways in which precipitation collects and either filters through the ground surface or not, and the relationship between this process and groundwater contamination.

Materials

paper
writing utensils

Background

Precipitation filters through the ground surface, evaporates, runs off, moves along pathways which eventually lead to some other water accumulation areas such as groundwater pockets, called aquifers, or from streams and rivers to oceans. This activity explores what happens to precipitation falling on the school grounds.

Procedure

1. Students prepare a map of the school grounds, indicating the location of buildings, outdoor play equipment, trees, and paved areas. Three copies of the map are prepared for use in the project.
2. Following a rainstorm, the school grounds are investigated for puddles and standing water, and locations are indicated on map #1.
3. After 30 minutes, map #2 is completed to indicate puddles and standing water.
4. After 60 minutes, Map #3 is completed.
5. Facilitate a student discussion of the following questions:
   a. Why did stormwater infiltrate into the soil more quickly in certain locations?
   b. What are the implications for groundwater contamination?

Pollution

Getting Out of a Bind

Primary Source
North Carolina Big Sweep. (1990). *Ripples: A big sweep elementary activity guide*. Raleigh, NC: Author.

Teaching Outcomes
To develop empathy for wildlife

Materials
large rubber band per student

Background

Humans are a special animal in that the hands, fingers and thumbs enable us to untangle ourselves from simple binds. If we were entangled in fishing line, for example, we could free ourselves by untying or cutting the line.

What happens, however, to wildlife? A seal, dolphin or duck does not have the options humans have. This activity simulates what might happen to an animal trapped by fishing line, nets, or other human-constructed articles.

Procedure

1. Using a volunteer to demonstrate, place a rubber band around the back of the student's hand, catching the thumb and little finger. Have the student try to remove the rubber band without using the other hand or teeth or rubbing it against something.
2. Distribute rubber bands to all students. Have each learner pretend that the hand and arm is a goose entangled in plastic. For example, the hand is its head, the fingers its beak and the forearm its neck. Cup the elbow with the free hand. Place the rubber band around either the "beak" or the "neck". Allow the students thirty seconds to free themselves. Do not allow the students to assist each other.

3. Begin the processing of the simulation by asking if all students were successful in getting free of the rubber band. In the wild, many animals cannot get free and can starve, strangle or suffocate.
4. Ask the students what types of plastics or other materials the rubber bands might represent in a natural setting. List these ideas on a chalk-board. (examples include fishing line, plastic six-pack rings, plastic bands, packing straps, fishing nets)
5. Have the students discuss how animals might get into a situation in which these types of materials might entangle it.

Going Further

1. FIELD TRIP: have students examine an area around the school, near a natural area, in a local stream to identify potential wildlife hazards. Make a list or a scrapbook of items found. For older students, you may wish to collect/clean up hazards you find.

2. EXTENDED DISCUSSION: lead the students in a discussion of how these hazards to wildlife may also be hazards to humans. Broaden the discussion to include how these hazards may come from activities that are beneficial to humans. At what point do they become hazards (at the point in which they become "pollution")?

Pollution

Determining Potential or Existing Threats to Community Groundwater

Primary Source

Concern. (1989). *Groundwater: A community action guide* (pp. 2-15). Washington, DC: Concern, Inc.

Teaching Outcomes

Students will determine whether there are potential or existing threats to community groundwater sources.

Background

Groundwater is a major source of drinking water for at least half the population in the United States. Groundwater contamination or depletion then, is a major concern. Many human activities may lead to depletion. One of these activities is called overdrafting, or drawing water from the aquifers faster than it is being replaced. Contamination is caused by many human activities related to industrial, agriculturial, municipal, and commercial practices. Citizens need to be aware of what their source of drinking water is and how to protect it from depletion and contamination. In this activity students will explore human activities related to the water supply for their own community.

Procedure

1. Divide the students into groups of 3-4. Distribute the following questions or question groups to the students for research. Be prepared to help facilitate the research.

<u>Determining potential or existing threats to your groundwater from industry:</u>

a. Are there any toxic disposal facilities or Superfund sites overlying your aquifer?

b. Which companies manufacture, process, or use toxic materials in your region? What type and quantity of toxics are being disposed of in the air, on the land, or in water? This is public information.

c. If there is oil and gas drilling, are these activities carefully regulated to prevent groundwater contamination? What provisions exist for overseeing safe brine disposal?

From commercial activities:

a. How do local gas stations and other vehicle maintenance operations prevent leakage from their underground storage tank systems and contamination from chemicals in maintenance? How do they recycle or dispose of their used oil and batteries?

b. How do local dry cleaners, printers, and other small businesses store, transport, recycle, and dispose of toxic materials?

c. How do area hospitals dispose of their contaminated refuse?

From government operations:

a. If de-icing salts are used in your area, are they stored carefully and applied sparingly?

b. What kind of pesticides are sprayed in public areas (parks, playgrounds, schools, hospitals, highways) and how often? What are alternatives available?

c. Have government facilities stored transported, and disposed of their toxic materials without harm to human health or the environment?

d. Are there conservation programs to eliminate wasteful uses of water?

e. Is projected population, industrial , or agricultural growth threatening to depleate your water supplies?

f. Is there adequate planning to balance water supplies among competing sectors?

From agricultural practices:

a. Are synthetic chemical pesticides and fertilizers used widely in your area? Are any known for their potential to leach into groundwater? Is the soil vulnerable to leaching?

b. What protective measures exist to manage animal waste on farms?

c. How do irrigation demands affect the availability of groundwater? Is the density of irrigation wells regulated?

From households:

a. What is the density and location of septic systems? What requirements exist for their construction, installation, maintenance, monitoring, and record-keeping?

b. What information exists for the safe use and disposal of household toxics (pesticides, oils, paints, and solvents)?

2. Have the groups give a class presention to allow the whole class to have access to the information. Put the information together in a class report booklet.

Going Further

Make copies and distribute to each student's family. Publicize each section in the local newspaper (maybe one section per week) for a community service/community education project.

Pollution

Groundwater Contamination and Community Response

Primary Source

East Michigan Environmental Action Council. (1989). *Groundwater quality protection in Oakland County: A sourcebook for teachers* (p. 70). Birmingham, MI: East Michigan Environmental Action Council. (ERIC Document Reproduction Service No. ED 257 685)

Teaching Outcomes

Students will become aware of different perspectives, interests, and issues involved with groundwater protection in a simulation of a groundwater contamination problem.

Materials

A copy of the problem as provided below and maybe a mock map to give a visual depiction of the problem to the students.

Background

Protecting groundwater supplies is a community need and responsibility. Building citizenship skills related to how to respond to and/or prevent groundwater contamination and an understanding of the complexity of the issues is the intent of this simulation activity.

Procedure

1. Present the following information to the students:

   Imagine that serious groundwater contamination has been found in your community but the source of the contamination is unknown. You are the owner of a nearby business which may be the source of the contamination. You are anxious to identify the source of the contamination so that cleanup can be initiated before additional pollution occurs. You are willing to assume responsibility if the contamination originated on your property, but you don't want to pay for studies and cleanup if other parties are responsible.

2. Students working individually or in small groups consider the following questions:

    a. What approach would you use to identify the source of contamination?

    b. What govenment agencies would be contacted to assist and supervise studies and cleanup?

    c. What sources of drinking water would be used while studies are being conducted? Who will pay for the drinking water?

    d. If you were a nearby business owner who was not responsible for the contamination, what would be your questions and concerns?

    e. If you were found to be responsible for the contamination, what would be your questions and concerns?

    f. If you were a local government official, what would your questions and concerns?

Going Further

Give the students the questions to answer as a homework assignment. This will give more time to reflect and do some searching for options. Ask each student to find a recent newspaper or magazine article reflecting a groundwater contamination issue. Ask the students to present their findings to the class or small group.

Note: Some useful references include

Groundwater Contamination Sites: A Citizen's Guide to Fact-Finding and Follow-up, published by the East Michigan Environmental Action Council, and

Groundwater: A Community Action Guide, published by CONCERN, Inc., 1794 Columbia Road, NW, Washington, DC 20009, (202) 328-8160.

What Is Acid Rain?

Primary Source

National Wildlife Federation. (1990). *Acid Rain: A teacher's guide* (p. 3). Washington, DC: National Wildlife Federation.

Teaching Outcomes

Students will measure the pH of several substances and apply outcomes to their understanding of what acid rain is.

Materials

pHydrion paper
beakers or jars
common substances (milk, juice, etc.)
marble chips
dirty pennies

Background

A solution is more acid when it contains more hydrogen ions, or charged hydrogen atoms. Acidity is measured on a pH scale that ranges from 0 to 14; 0 is extremely acidic, 14 is extremely alkaline or basic, and 7 is neutral. The scale progresses logarithmically. Thus, pH 3 is 10 times more acid that pH 4 and 100 times more acid that pH 5. PHydrion papers will indicate a pH range between 0 (very acid) to 12 (alkaline).

Procedure

1. Collect some common substances (such as vinegar, milk, soft drink, lemon juice, dissolved baking soda, ect.) in small jars or beakers.
2. Students can measure and record the pH of the substances and rank them according to pH from 0 to 12.
3. Place small marble chips or pennies in each beaker and watch them for 48 hours. How does acidity affect the materials. What could acid in rain do to water, amphibians, fish, plants, other animals, soil, buildings, cars, people?

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Going Further

With an understanding that rain water may naturally be acidic in most regions of the country, have the students explore the pH level of different sources of water in their own community. Obtain samples of water from area ponds, lakes, or streams. Find out from community resource people (water quality control office or wildlife agency) if the pH level of rain has changed recently. Has acid rain affected your community? state?

Pollution

Pollution Patrol

Primary Source

National Wildlife Federation. (1990). *Acid Rain: A teacher's guide* (p. 4). Washington, DC: National Wildlife Federation.

Teaching Outcome

The students will learn the sources of acid rain-causing pollution.

Materials

local factory or utility plants that produce SO_2 pollution

Background

The acid rain problem begins at the smokestacks of coal-burning utilities and factories and the tailpipes of motor vehicles. The two main culprits are the pollutants from human activities: 1) sulphur dioxide (SO_2) from the coal burning plants, and 2) nitrogen oxides (NO_x) from car and truck exhaust.

Millions of tons of these pollutants are sent high into the atmosphere where they can travel hundreds of miles by wind. They can then react with water vapor to form sulfuric and nitric acids and then fall to earth as acid rain, snow, hail, and even fog.

Procedure

1. Ask one or more of the students to find out if your community has some factories or utility plants. If it does, have some students contact the state air pollution control office, to see if any of these factories or utility plants produce SO_2 pollution. (The state air pollution control office is usually located in the state capital. The local government would have the address.)

2. Determine the approximate amount of car-produced nitrogen oxides (NO_x) in the community. To do this you will need three figures: 1) the average amount of NO_x produced by each vehicle per mile; 2) the average length of each vehicle trip, and 3) the average daily number of cars on your community's roads. The first two figures are readily available because the EPA, in 1982, estimated average vehicle NO_x production as 4 grams per mile, and average trip distance as 5 miles per trip. To determine the third figure, the average number of cars on the road, the students will have to collect some data. Here is how to do it:

   a) Pick a point on a road that is neither overly congested nor traffic free and estimate the number of cars that pass that point in a day. You can do this by counting the number of cars passing the point in 15 minutes, multiply by 4 to get the number per hour and multiply by 24 to get the average number per day. (Since each car travels an average of 5 miles, this figure indicates the number of cars in an average 5 mile segment of road.)

   b) Determine the number of 5 mile segments of road in your community by dividing the total number of miles of roads by 5.

   c) Multiply the number of 5 mile segments in your community by the average number of cars in a 5 mile segment to get the total estimated number of cars using your community's roads in one day.

3. Since each of these cars produces 4 grams of NO_x per mile and each car travels an average of 5 miles, to estimate the total number of grams of NO_x produced per day in your community use this formula: number of cars on your community's roads in a day x 4 grams of NO_x per car per mile x 5 (the average number of miles each car travels.) Ask the students how this might contribute to acid rain.

Going Further

Ask your local county health department if your community has an air quality monitoring station you can visit. At the station, you should be able to see the filter that has trapped tiny air-borne particles in the station's air sampler, and compare its condition with a fresh filter, as well as observe the station's latest readings on SO_2, carbon monoxide, and ozone (the last two mostly coming from motor vehicle exhaust). The station official should be able to explain some of the pollutants' sources, daily and seasonal variations, and some public health ramifications.

Cleanup...

Nature's Cleaning Process

Primary Source

Vine, V. (1981). *Local watershed problem studies: Elementary school curricula* (p. 83). Madison, WI: Water Resources Center.

Teaching Outcomes

Students simulate the process of waste removal which occurs in a septic drain field.

Materials

jar of murky water
flower pot filled with layers of sand and charcoal
cotton plug for the drainage hole at the bottom of the flower pot
empty jar
food coloring

Background

In rural areas, wastewater enters a drain field after solids have settled out. The drain field is composed of soil through which the wastewater filters to the groundwater.

Procedure

1. One student pours the murky water into the flower pot that is held by another student. The flower pot is held over the empty jar.
2. Ask the students to describe the difference between the murky water before it was poured into the flower pot and what drains out of the flower pot and into the glass jar. Ask the students what happened to the debris in the water.
3. Explain that the flower pot simulates a drain field used in many rural areas to handle waste water. Ask the students to describe how they envision a drain field working. Why are drain fields used? Where does the water come from that enters a drain field?
4. Ask the students what would happen if too much water was poured into the flower pot at one time? Continue the demonstration and find out.

5. Ask the students what would happen if toxic chemicals were present in the waste water? Using food coloring to represent the presence of toxic chemicals repeat the demonstration. What chemicals might families dispose of in the toilet or kitchen sink which would enter the septic drain field? How would this affect the groundwater? How else could these chemicals be disposed of? How necessary is it that these chemicals are used?

Going Further

Ask each student (with the help of a parent) to identify one toxic or dangerous chemical used in their home and an alternative that is less dangerous or harmful if released into the groundwater.* Create a bulletin board or poster listing these options.

* There are many references available that list alternatives. Two from ERIC include:

Disinger, J. F., & Lisowski, M. (1985). *Teaching about hazardous and toxic materials.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ED 273 432)

Howe, R. W., Disinger, J. F., & Wilson, T. L. (1989). *Activities for teaching about hazardous materials in the home.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ED 326 381)

Cleanup...

Soil as Filter

Primary Source

Privette, C., McAlhany, F., & Dukes, G. (Eds.). *Teaching aquifer protection: A curriculum supplement for grades 4-6.* Clemson, SC: Cooperative Extension Service, Clemson University.

Teaching Outcomes

Students will examine how the soil type influences infiltration of chemicals before reaching groundwater.

Materials

6 jars with lids labeled 1-6
1 tsp. sugar
3 drops of food coloring
1 tsp. of vegetable oil
2 funnels
2 filters
3 tbsp. sand
3 tbsp. potting soil

Background

Some chemicals in the water, such as phosphate, are filtered out by the soil before they reach the groundwater. These chemicals are absorbed onto the soil particles. Other chemicals (for example, nitrate) are soluble and therefore will not be strongly absorbed by soil particles. These soluble chemicals are more likely to move into and contaminate the groundwater. The type of soil influences which chemicals and how much of them are removed before infiltrating water gets to the groundwater.

Procedure

1. Fill the first four jars halfway with water. Add the following to the jars labeled 1-3: 1 tsp sugar to jar 1; 3 drops of food coloring to jar 2; and 1 tsp vegetable oil to jar 3. Jar 4 should only contain water.
2. Place the lids on the jars and shake. Have the students make two columns on a piece of notebook paper. In column one ask the students to describe the water in jar 1, jar 2, jar 3, jar 4 (clarity, color, taste). Label this column "Before."
3. Tell the students that the first 4 jars represent water that has been contaminated. The sugar, food coloring, and vegetable oil all represent a chemical contaminant in the water. Ask them if they can think of other water contaminants?

4. Set up the soil filters. Add filter paper and the sand to one funnel. Put filter paper and the potting soil in the second.
5. Hold the funnels over jars 5 and 6. Pour half of the contents of jar 1 in each funnel. Label the second column "After." Divide the second column in half. Label each half "sand" or "soil." Ask the students to describe the water from jar 1 after it has passed through the funnels in the second column. Empty jars 5 and 6 and repeat the procedure using jars 2, 3, and 4.
6. Discuss what is a more effective filter: sand or soil. Ask for observations about what substances are easy and which are hard to filter out? What can these observations tell us about chemical spills in sandy areas/soil? What can these observations tell us about spills in our own yards?

Going Further

This can lead naturally into a discussion about where the water goes. Explore the ideas the students may identify and introduce the concepts of groundwater and the aquifer as sources of fresh water for many communities throughout the world.

Cleanup...

Wetlands—Our Natural Purification System (3 Parts)

Primary Source

Lynn, B. (1988). *Discover wetlands: A curriculum guide* (pp.65-73). Olympia, WA: Washington State Department of Ecology. (ERIC Document Reproduction Service No. ED 309 986)

Teaching Outcomes

Students will learn three ways wetlands purify water, and will be able to describe why water purification is important to people.

Materials

Part One: Sediments—Nature's Filter

4 used, two-liter plastic bottles; 4 - 3 inch squares of screen or mesh; 4 rubber bands; 4 sturdy cardboard boxes to support the filters; 1 gallon quantities of filter materials: rich topsoil, subsoil, sand, gravel, pebbles, 1 cup of pulverized charcoal briquettes; 4 - 1 quart or liter jars; 1 quart vinegar; 1 quart of rubbing alcohol; litmus paper for pH test

Background

Polluted water is harmful to life in a variety of ways. For example, heavy metals, such as copper, and some organic chemicals can cause fish kills and degrade aquatic habitats. Suspended sediments can destroy fish spawning beds, suffocate filter feeders such as clams, abrade fish gills and impair the vision of predators seeking their next meal.

Wetlands can help purify water in a variety of ways. The activities in this lesson plan describes the three ways in which this phenomenon happens: water can be filtered by sediments of a wetland before entering the groundwater; wetland plants can adsorb excess nutrients and toxic substances and reduce pollutant levels; wetland plants slow the flow of water allowing more time for potentially harmful sediments to settle out.

An important thing to remember is that these activities describe how wetlands affect water quality. What happens to the pollutants after being absorbed by the plants, or bound up in the sediments, is still not very well understood. In some cases pollutants are converted to less toxic forms. In other situations, however, the pollutant remains toxic and may be "re-activated" if the sediments are disturbed (e.g. by dredging) or if the plants which absorbed it die. Caution students that while wetlands can purify water to some extent, the ultimate solution is to reduce the amount of toxics released into the environment.

Part One: Sediment—Nature's Filter

Procedure

1. Have the students set up the filter system (see diagram).
2. Divide the class into teams, one at each of four stations. Each station will need the equipment specified under "materials". There are four different solutions to be tested, one at each of the stations. They are:

   Station One: 1 quart or liter of tap water mixed with 1/2 cup (or 100 ml) of rubbing alcohol.

   Station Two: 1 quart or liter of tap water mixed with 1/2 cup (or 100 ml) of saturated saltwater.

   Station Three: 1 quart or liter of tap water mixed with 1/2 cup (or 100 ml) of vinegar.

   Station Four: 1 quart or liter of tap water mixed with 1/2 cup (or 100 ml) of crushed charcoal.

3. Identify the alcohol, saltwater, vinegar and charcoal as pollutants. Ask each team to observe, describe and record their findings concerning the characteristics of their solution: smell, transparency or cloudiness, and pH. Note: No tasting.
4. Next, each team slowly pours its solution through its filter system. Be sure there is a large enough container beneath the filter to catch the flow. Have the students examine the outflow for the same characteristics of smell, transparency or cloudness, and pH.

   (The odor of the liquid contaminants will most likely persist through the filtering. The charcoal in suspension will most likely not make it through the filter. The pH factor may vary depending upon the composition of the soil, but the acidity of the vinegar should still be traceable.)

5. You may want to repeat the process using full strength pollutants. The saturated salt water, alcohol, and vinegar should show dramatically in the outflow. The charcoal will merely coat the soil.
6. Repeat the process with clear water. Test and record descriptions of the outflow. How many filterings are needed before the water seems free of the contaminants that have been trapped in the soil?
7. Discard the filtered water. Do so carefully as it may clog sink drains. Filter it through a cloth before pouring it in sinks or toilets. The soil and gravel should be dried and discarded in thin layers in places that are not vegetated.

8. Summarize the events of this study—the exploration of solutions, the filtration action of the soil, and even the issue of safe disposal of the "waste" materials. Emphasize the vulnerability of aquatic wildlife and aquatic habitats to water pollution. The major component of their habitat is water.

Part Two: Plants—Nature's Filters

Materials

beaker or jar
food coloring
fresh celery stalks

Procedure

Prepare this demonstration (steps 1 and 3) one day prior to class study. Repeat steps 1 and 3 in front of the class to show how the demonstration was prepared.

1. Prepare a solution in a beaker by adding several drops of food coloring to water. Explain that the food coloring represents pollution by a toxic substance. Ask the students for examples of toxic substances.
2. Ask the students to imagine water flowing into a wetland with many wetland plants. Tell them that the celery stalks are like the plants of the wetland. Ask the students for examples of wetland plants.
3. Cut off the bottom half inch of the celery stalks and place them in water overnight. As time passes the colored water will visibly travel up the stalks, showing how plants can absorb pollutants with the water they "drink." If the colored water is not visible from the outside of the stalk, break it open to see the colored water inside the plant tissue.
4. Summarize with the following questions as discussion starters:

    a. How do wetland plants help to purify water?

    b. Is the water in the beaker still polluted? Why or Why not?

    c. Where does the water go after uptake into the plant?

    d. What happens to the pollutants?

    e. Why can't we dump all our our waste water into wetlands?

Part Three: Plants and Sediment as Filtering Partners

Materials

1 quart or liter jar with lid
a variety of sediment (pebbles, sand, sandy dirt, leafy dirt, and clay)
clock or stopwatch
piece of artificial grass (doormat)
flat sheet of wood or plastic similiar in size to the artificial grass
2 shallow aluminum pans

Procedure

1. Explain that flowing water carries sediments of different sizes. The faster the flow, the larger the sediment particle that can be transported by suspension. As the water is slowed the larger particles settle out first. In still water, the finer sediments (clay and silt) will settle to the bottom last.
2. Mix the different sediments (sand, dirt, etc) together in the jar, filling it 1/2 to 3/4 full. Top off the jar with water, and put the lid on. Have a student shake the jar well until thoroughly mixed and set the jar on the table in front of the class. Begin timing.
3. As the sediments begin to settle, explain that the muddy water loaded with sediments can be harmful to wildlife. Ask them to think of reasons why. Would more sediments settle to the bottom if the water was flowing quickly or slowly?
4. Check the sediment jar. How long did it take to settle out completely? Ask the students to describe how the sediments settled and to guess why.
5. Describe how wetlands can slow the flow of water in a system by simply "being in the way" of water.
6. Set up the "artificial wetlands" (the doormat and the flat piece of wood) so they are both on a slight tilt. Explain that the doormat is a healthy wetland, filled with plants, and the piece of wood is an unhealthy wetland where the plants have either died or been removed. In both wetlands, water enters through a stream, flows through the wetland, and eventually into a lake.
7. Place a pan at the low end of each "wetland" and pour water simultaneously into the high end of each.
8. Facilitate a discussion around the following questions:

   a. In which "wetland" does the water flow through the fastest?

   b. In which "wetland" would more sediments settle out?

   c. Which "wetland" would have cleaner water flowing from it?

d. How would channeling (i.e. dredging a ditch through) a wetland affect water quality downstream?

e. How would this affect people and other animals?

Going Further

Ask students to locate wetlands nearest to the school on a topographic map. Explore the watershed of the area for the sources of water for the wetland. Facilitate a student discussion about possible human activity in the area that could lead to water contamination. Visit the area to examine the health of the wetland. Identify the plants in the wetland. Obtain some sediment from the wetland and have it tested for its chemical composition.

Make a research assignment. There are many research projects and examples of actual use of and/or creation of wetlands for city water purification needs. Ask each student to find one article concerning wetlands and their water purification capabilities, recent research, or wetland issue. Have each student share his/her findings with the class or divide the class into smaller groups for sharing.

Cleanup...

Giant Sponges

Primary Source

Lynn, B. (1988). *Discover wetlands: A curriculum guide* (p. 57-59). Olympia, WA: Washington State Department of Ecology. (ERIC Document Reproduction Service No. ED 309 986)

Teaching Outcomes

Students will demonstrate the water-holding properities of wetlands and understand how this function is important to people.

Materials

Large shallow pans such as aluminum pans or greenhouse germination flats, 1 per every 5 students; modeling clay; florists foam or a large sponge; variety of model-building materials such as toothpicks, cheesecloth, pipe cleaners, natural materials including pine needles, twigs, grass, weeds, and soil; muddy water

Background

Many wetlands, because of their structure, can absorb and store large volumes of water. In the floodplain of a river, this function plays a key role. During storms, adjacent wetlands soak up excess water and store it in absorbent, organic solid. Then, the water is either gradually released back to the river, evaporated into the atmosphere, or in some cases filtered through sediments to the groundwater below. Flood peaks and flood damage are reduced, and in some areas our ground water supply is recharged.

Where riverine (of rivers) wetlands have been destroyed or altered, rising waters have nowhere to escape and may flow downstream or over banks, causing in some instances, extensive damage to our urban and agricultural areas.

Procedure

1. Divide the class into groups of five and give each group a pan, some foam or sponge, modeling clay and other model building materials.
2. Instruct each group to build a wetland model:
   a. Spread a layer of modeling clay in half of the roasting pan to represent land. Leave the other half of the pan empty to represent a lake, river, or ocean.

   b. Shape the clay so that it gradually slopes down to the body of water.

   c. Smooth the clay along the sides of the pan to seal the edges. You can also form meandering streams in the clay that lead into the body of water.

   d. Cut a piece of the florists foam to completely fill the space across the edge of the clay. The foam represents the wetland buffer between dry land and open water.

e. Students can add final touches to their model by attaching plants (natural materials) and animals molded in clay with toothpicks. Have students create their models by looking at pictures of different wetlands. Here are a few ideas:

Use cotton swabs painted brown for cattails.
Use long pine needles for reeds.
Make trees by gluing pieces of green sponge onto twigs.

3. Discuss how wetlands are very complicated natural systems and that scientists are still learning more about how they work. One important thing they do know about wetlands is that they help reduce flood damage by soaking up excess water and slowly releasing it into streams, lakes, etc.
4. Have the students simulate rainstorms by slowly pouring muddy water onto the land area of their model. Have them describe what happens.
5. Look at the water now in the water body of the model. Is it still dirty? Discuss the value of the freshwater marsh in water filtration and pollution reduction.
6. What would happen if the wetland wasn't there? Remove the wetland from the model and pour the same amount of muddy water on the land. Note any differences. Explain that most wetlands are shallow basins that collect water and slow its rate of flow. This slowing process helps reduce flooding and allows sediments to settle.
7. Have students change the size of the wetland in the model and repeat the experiment. What happens? Why? What would happen if the wetland was paved over? What would happen to areas downstream? Why are wetlands important to people?

Cleanup...

Wet Land in the Wetlands

Primary Source

Lynn, B. (1988). *Discover wetlands: A curriculum guide* (p.60-61). Olympia, WA: Washington State Department of Ecology. (ERIC Document Reproduction Service No. ED 309 986)

Teaching Outcomes

Using a variety of natural materials, students will observe the way different natural materials soak up water and understand one way in which wetlands control floods.

Materials

kitchen sieve
cheesecloth to cover the sieve
bowl large enough to hold the sieve
scale
sphagnum moss
peat moss
sod
sand
piece of rock

Background

Many wetlands, because of their structure, can absorb and store large volumes of water. In the floodplain of a river, this function plays a key role. During storms, adjacent wetlands soak up excess water and store it in absorbent, organic solid. Then, the water is either gradually released back to the river, evaporated into the atmosphere, or in some cases filtered through sediments to the groundwater below. Flood peaks and flood damage are reduced, and in some areas our ground water supply is recharged.

Procedure

1. Have students weigh equal samples of each material. Each of the five samples should weigh about the same.
2. Put the cheesecloth in the sieve and place the sieve in the bowl. Place the sample of sphagnum moss in the cheesecloth/sieve and weigh the bowl, sieve, and moss. Write down the weight.
3. Add water to the bowl until it is nearly full. Let the sieve and moss sit in the water for five munites. Take the sieve out of the bowl and pour the water out of the bowl. Some water may drip out of the sieve for a few seconds. Do not squeeze any water from the moss or the sieve.

4. Place the sieve back in the bowl and weigh the bowl, sieve and moss again. Record the weight beside the dry weight.
5. Repeat this activity using each of the other materials listed in the materials list. Write down the weights in columns below the dry and wet weights of the moss.
6. What is the weight of water each material soaked up? Find out by subtracting the number in the first column from the number in the second column. Write the result in a third column.
7. Have students organize and display the results in a way that enhances understanding such as bar graphs.
8. Which material tested holds water best? Which of the materials tested would be most likely to be found in a wetland? (Mosses and sod. Sand and rock may be below the mosses and sod, but their role in water storage is less important.) From this experience, what is one way wetlands help control floods?

Cleanup...

Slick Cleanup Experiment

Primary Source

Purdue University Cooperative Extension Service. *Indiana's water riches: Instructor's guide* (pp. 60-65). West Layfayette, IN: Purdue University Cooperataive Extension Service.

Teaching Outcomes

Students construct a model oil spill and test the effectiveness of various materials in cleaning up the oil spill.

Materials

- foil baking pan
- paper cupcake liners
- cooking oil
- dropper
- pipe cleaners
- "Slick Cleanup" handout copies
- clean up materials per group (cotton balls, cotton swabs, paper towels, coffee filters, plastic spoons, pieces of sponge, string, straws, pieces of straw strung on string, nylon net, other available materials).

Background

Oil spills threaten water habitats, and poison and kill aquatic life. Oil spills are very expensive and time consuming to clean up; the clean up process is not always effective.

Procedure

1. Fill the pan approximately 2/3 full of water. This represents the ocean.
2. Students can make sea birds from the pipe cleaners. Hang the birds on the edge of the pan.
3. Place approximately 20 drops of oil in a cupcake liner to simulate an oil tanker and float this tanker on the ocean.
4. Create an oil spill: Students can use their imaginations to create storms to capsize the boat, collisions, and leaks in the hull of the cupcake liner boat.
5. Using the different clean-up materials, try to clean up the ocean, shore, and birds.

6. Describe how well each of the materials worked on the handout. Ask the students if they were 100% effective in cleaning up the spill (They probably weren't.) Which material seemed to work best? How would weather conditions affect clean-up efforts? Could any of the oil be recovered for use? What is easier or makes more sense: pollution prevention or pollution clean-up?
7. For each clean-up method, discuss additional environmental damage that the treatment could cause. Considering the pros and cons of each treatment, which one would you recommend?

Going Further

Ask each student to bring and share with the class an article about oil spills. How do the articles relate to the activity?

Name________________

Slick Clean-Up Handout

Write the name of each of the clean-up materials you tried and how it worked when cleaning up the oil slick. Answer the question at the bottom of the page.

Material	Clean-up
____________________	________________________
____________________	________________________
____________________	________________________
____________________	________________________
____________________	________________________
____________________	________________________
____________________	________________________
____________________	________________________
____________________	________________________

Which materials worked the best in cleaning up the oil slick?

____

____

Describe how that material cleaned up the oil.

____

____

Which material did the poorest job cleaning up the oil?

____

Water Quality

Surface Water - Ground Water Quality

Primary Source

Nebraska Natural Resources Commission. (1991). *Stop, look and learn about our natural world vol 3, grades 5-6* (pp. 111-13). Lincoln, NE: Nebraska Natural Resources Commission.

Teaching Outcomes

Students will learn how water quality can impact various uses of surface water and how it can be protected from various pollutants. The students will rate the pollutants that often get into water and limit its uses.

Materials

copy of terminology for students

Background

Water Source Definitions

1. Surface Water Supplies: Water on the earth's surface that is available for us to use for many purposes. Examples are water in streams, rivers, ponds and lakes. Streams and rivers get water from storm and snow melt runoff and from springs that release water from groundwater sources. Ponds and lakes receive water from streams, rivers and spring flows.
2. Groundwater Supplies: Water that seeps or percolates into the soil and is stored in an aquifer (water bearing material like gravel) from which we can pump it out to use.

Water Quality Definitions (Definitions of six classes of pollutants that could get in our lakes and stream water.)

1. Sediment: Soil that has been washed off a field by water or blown off by the wind. It often damages streams, ponds, and lakes.

2. Debris: Loose materials that can be washed or blown into a water supply. Examples are paper, cans, bottles, dead plants, dead animals, plastic containers, etc.

3. Nutrients: Substances that are necessary for plant growth. Nutrients in the soil are taken up by plant roots and used to produce plant growth. Fertilizers are nutrients that are applied by people to increase plant growth and crop production. Two common nutrients that are a problem in water supplies are nitrates and phosphates.

4. Pesticides: Human-made materials that are used to kill pests. Examples are: Herbicides are used to kill certain plants. Insecticides are used to kill insects. Rodenticides are used to kill rodents.
5. Algae: Simple one-celled or many-celled plants, capable of photosynthesis. These plants can grow excessively in water when the water contains a rich supply of nutrients. Too much algae in lakes can reduce the numbers of fish and other aquatic life.
6. Soaps and Detergents: Materials used for cleaning that can get in water supplies. Examples are hand soap, dish soap, clothing soap, degreasers and paint thinners. These are difficult to remove at sewage treatment plants.

Procedure

1. Discuss and identify local surface water supplies and groundwater supplies. How important are they to people and wildlife?
2. Refer to the Water Quality Definitions and lead a brief discussion on surface water pollutants. Allow the students to read each definition and share personal or indirect experiences with each pollutant.
3. Make a transparency and copy of the pollution rating chart. Have one student keep score. Color the "P.M." blocks red and the "Y" blocks blue for a visual aid.
4. Discuss how surface water could be protected from these pollutants.

Going Further

Instead of conducting the last step as suggested above divide up the class into groups and assign each group one of the listed pollutants. Each group could research a pollutant and establish how the surface water could be protected from this source. This information should then be shared with the class.

Pollution Rating Chart for Surface Water

Could you tolerate some of the pollutants in the water uses listed in the chart below? Place a "Y" for Yes and an "P.M." for proper management needed to explain whether you could tolerate the pollutants in the diagram with the listed water uses.

Y = Yes this pollutant is okay in this water use.

P.M. = Proper management is needed to keep these pollutants out of the listed water use.

		Sediment	Nutrients Nitrogen and Phosphorus	Pesticides	Algae	Soaps and Detergents	Debris
Recreation:	Swimming						
	Boating						
	Fishing						
	Water Skiing						
Industrial:	Cleaning Agent						
	Cooling Engines						
	Irrigation						
	Firefighting						
	Electricity Generation						
Personal:	Drinking Water						
	Showers						
	Washing Dishes						
	Sewage Transport						
	Irrigation						

Water Quality

Can the Soil Cope?

Primary Source

National Wildlife Federation. (1990). *Acid Rain: A teacher's guide* (p. 6). Washington, DC: National Wildlife Federation.

Teaching Outcomes

Students will determine the buffering capacity of area soil.

Materials

small plastic garbage bags
soil samples
funnels
filter paper
beakers
pH paper
vinegar
large containers

Background

Acid rain can completely eliminate life in lakes, streams, ponds, and even rain pools. However, the amount of damage it does depends largely upon an area's soil. Rainwater trickles through soil to the groundwater and then can enter lakes and streams. Only alkaline soils can neutralize or buffer the rain's acid.

Procedure

1. Obtain a soil map of the local area to determine the location of different soil types in your vicinity. Have the students collect soil samples (or do so yourself) from these locations in small plastic bags.
2. In the classroom make funnels from bleach bottles and put filter paper in the bottom of each funnel. Fill each funnel with one pound (or .45 kg) of a different soil sample and place over the large containers.
3. Add 50 ml of vinegar to 150 ml of water to make a solution with a pH of 4.0. Pour it over the soil samples, and measure its pH again, once it has percolated through the soil into the container.
4. Compare the results to determine which soil has the best buffering capacity. How is soil type related to acid rain?

Going Further

Ask your local Soil Conservation Service agents how soil type is related to acid rain. How has acid rain affected your community?

Water Quality

The Comparitive Color Block Indicator

Primary Source

Haney, R. (Ed.). (1978). *A sourcebook of marine activities developed in the Milwaukee great lakes summer education program, 1977 and 1978* (pp. 60-61). (ERIC Document Reproduction Service No. ED 207 851)

Teaching Outcomes

Students will measure Ph using the comparative color bock indicator.

Materials

- comparative color block indicator kit
- lemon juice
- vinegar
- milk
- HCl
- baking soda
- lake water
- river water

Background

In addition to hydrion paper and universal indicators, the comparative color block indicator is another method for determining pH. Standard differently colored test tubes are provided in the test kit. Each color represents a specific pH. If a substance matches the color of one of the standards, after an indicator has been added, then it has the same pH as the standard.

Procedure

Ask the students to list the substances from the materials list on a clean sheet of paper. Fill the blank tube with the test substance (lemon juice, vinegar, or milk, etc.). Add 5 drops of standard solution and mix gently. Hold up to light and choose the standard that matches the mixture. Record the pH of the matching tube. Follow this process for each of the substances, recording the pH beside each substance on the list.

Going Further

Introduce other methods for determining pH (i.e. pH meter, pHydrion paper, Hach wide range indicator kit, Pocket lab, ect.)

Resources

The activities in this collection were drawn from a variety of sources. We recommend that, for additional information or ordering of these publications, you contact the publisher directly. Many of these activities are under copyright, and the ownership of the activities remains with the publisher. There may be a charge for the full curricular piece or activity guide, but the cost is uniformly low. You may also wish to inquire as to other teaching resources these publishers have available.

Activity Guide	Order/Inquiry	Phone
Acid Rain: A Teacher's Guide from *Pollution: Problems & Solutions* (Naturescope)	National Wildlife Federation 1400 Sixteenth Street, NW Washington, DC 20036-2266	202/797-6800
Cscape in-school	Carson City/Storey County	702/784-4848
Curriculum (ent 90 EWOI-1-9234)	Cooperative Extension 675 Fairview @ 229 Carson City, NE 89701	
Discover Wetlands: A Curriculum Guide	Washington State Dept. of Ecology Shorelands and Costal Zone Management Program P.O. Box 47600 Olympia, WA 98504-7600	206/459-6774
50 Simple Things You Can Do to Save the Earth	Earthworks Press 1400 Shatuck Ave. #25 Berkeley, CA 94709	510/841-5866
Groundwater Quality Protection in Oakland County: A Sourcebook for Teachers	East Michigan Environmental Action Council 21220 W. 14 Mile Road Bloomfield, MI 48301	313/258-5188
Indiana's Water Riches	Purdue University Cooperative Extension Service Purdue University West Lafayette, IN 47906	317/494-8491
Living in Water: An Aquatic Science Curriculum for Grades 4-6	National Aquarium in Baltimore Education Dept. Pier 3, 501 E. Pratt Street Baltimore, MD 21202-3194	410/576-3800
Ripples: A Big Sweep Elementary Activity Guide	Big Sweep Educational Materials P.O. Box 94876 Lincoln, NE 68509-4876	919/856-6686

Sandcastle Moats and Petunia Bed Holes	Virginia Water Resources Research Center 617 N. Main Street Blacksburg, VA 24060-3397	703/231-5624
A Sourcebook of Marine Activities Developed in Milwaukee Great Lakes Summer Education Program, 1977 & 1988 (ED 207 851)	ERIC Documentation Reproduction Service 7420 Fullerton Road, Suite 110 Springfield, VA 22153-2852	800/443-2852
Stop, Look and Learn about Our Natural World	Nebraska Natural Resources Commission 301 Centennial Mall South P.O. Box 94876 Lincoln, NE 68509-4876	402/471-2081
Teaching Aquifer Protection: A Curriculum Supplement for Grades 4-6	Cooperative Extension Service Clemson University Barre Hall Clemson, SC 29634-0313	803/656-3384
The Water Around Us	University of Vermont Extension RR # 4 Box 2298 Comstock Road, Berlin Montpelier, VT 05602-8927	802/223-2389
Water Riches: Teacher's Guide	Nebraska Cooperative Extension Service University of Nebraska-Lincoln Agricultural Hall Lincoln, NE 68583-0771	402/472-2824
Water Wizards: School Program on Water Conservation for Third and Fourth Grade Levels	Massachusetts Water Resources Authority Charleston Navy Yard 100 First Avenue Boston, MA 02129	614/242-6000
Water: The Liquid of Life	Illinois State Environmental Protection Agency 2200 Churchill Road P.O. Box 10276	219/782-3397

A Brief Guide to ERIC

The Educational Resources Information Center
Office of Educational Research and Improvement
U.S. Department of Education

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University Microfilms International (UMI)
Article Clearinghouse
300 North Zeeb Road
Ann Arbor, MI 48106
Telephone: (800) 732-0616

Institute for Scientific Information (ISI)
Genuine Article Service
3501 Market Street
Philadelphia, PA 19104
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