Explorations Into Water

Teaching Curriculum

The Importance of Water – Activities for students, grades 3 through 6 (ages 8-12)

EXPLORATIONS INTO WATER

What is it?

Rain Bird's *Explorations Into Water* Teaching Curriculum is an educational tool providing teachers and parents with specific lesson plans and related course work geared to students in grades 3-6. It is available for downloading at http://www.rainbird. com.

What is its purpose?

Rain Bird and Dr. Stefanie Saccoman at California State Polytechnic University, Pomona (Cal Poly Pomona) designed the program to motivate students to think about the part each person plays – and the actions they can take in using and conserving water.

The curriculum gives students the opportunity to explore the critical role water plays on Earth by investigating issues and challenges in water management and conservation in the same manner that scientists and engineers do in the field – through research and experimentation.

Who should use it?

Teachers and parents. Teachers who are seeking an engaging resource to teach students about the need for water conservation. Parents who are looking for easy to understand, educational and fun interactive ways to bring the importance of water conservation into the home.

Is the information easy to use?

Yes. The program, geared for students in upper elementary school, focuses on water management, conservation and preservation by linking abstract ideas and scientific concepts through fun, hands-on outdoor activities and classroom demonstrations.

The information is well organized and self-explanatory. The curriculum contains projects that integrate science with art; data gathering, observation, and inference;

analysis of physical matter; in-class demonstrations that can be presented by teachers for students; and at-home projects that illustrate scientific principles in a manner that is understandable and meaningful to school-age children.

Why the focus on water conservation?

As a pioneer in irrigation, Rain Bird realizes the importance of water in sustaining life, and therefore actively supports and educates the public on the importance of water conservation and its critical role in the environment. Rain Bird believes that educating the public on the importance of water conservation begins both in the classroom and at home.

The *Explorations Into Water* Teaching Curriculum is the most recent expansion of Rain Bird's commitment to environmental education. In 2002, three Rain Bird Rain Forest Learning Centers were unveiled at Cal Poly Pomona's BioTrek Project. Located on the Cal Poly campus, the three learning centers add a physical presence to Rain Bird's Rain Forest Teaching Curriculum, which is widely used, and also available www.rainbird.com.

About Rain Bird:

Rain Bird Corporation, based in Azusa, CA, is the world's largest manufacturer of irrigation equipment and related accessories. Since its beginnings in 1933, Rain Bird has offered the industry's broadest range of irrigation products for golf courses, sports arenas, farms, commercial developments, and homes in more than 130 countries around the world. Rain Bird has been awarded over 130 patents, including the first in 1935 for the impact sprinkler. Rain Bird and The Intelligent Use of Water™ is about using water wisely. In addition, the company's commitment extends beyond products to education, training and services for the industry and the community. Rain Bird maintains state-of-the-art manufacturing assembly facilities in the United States, France, Sweden and Mexico.

www.rainbird.com

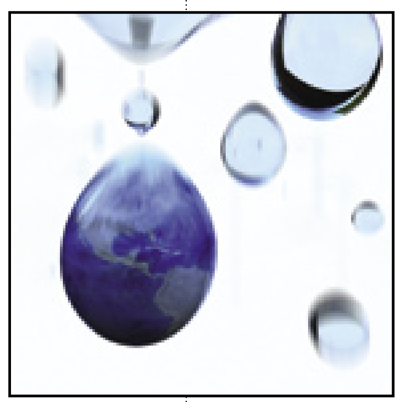
Explorations into Water

Curriculum for Upper Elementary Grades

The Importance of Water – Activities for students grades 3 through 6 (ages 8–12)

Water and Its Role on Our Planet – Scientific & Historical Perspectives

Water appears to be the simplest thing around, but while pure water is colorless, odorless and tasteless, it is vital for all life on Earth. Simply put, where there is water there is life, and where water is scarce, so too is life. Water is so essential to sustaining life, that it is proven that humans are capable of surviving longer without food than they are without water.



So what is it about water that makes it so important to us? And what is it about water that makes it water? This curriculum explores the physical and chemical properties of water and why water is so critical to living things.

Each year, the planet receives about 89.2 billion acre-feet* of water from precipitation, but only 10 percent pours into areas in which it can be used with the remaining 90 percent pouring down in inaccessible mountains and swamps and flowing to the sea before it can be captured and used. Water is continually being recycled in the form of water vapor, liquid water and ice. Because the Earth is primarily a "closed system," like a terrarium, it neither gains nor loses much water. In other words, the same water that existed on Earth millions of years ago is still here.

Water is formed by combining hydrogen and oxygen atoms in a 2:1 ratio, and is called the "universal solvent" because it dissolves more substances than any other liquid. This means that wherever water goes, either through the ground or through our bodies, it takes along valuable chemicals, minerals and nutrients.

Water's unique property is that it is the only known natural substance that is readily found in all three forms — liquid, solid (ice) and gas (steam) — at the temperatures normally found on Earth. Each form plays an important role in sustaining life on Earth.

Because Earth has a fixed supply of water, we cannot afford to waste or pollute it. Taking care of the water available to us on our planet is everyone's responsibility. We all need the water and we all need to look after its quality. In this curriculum we will explore ways in which we can understand water as a precious resource.

** Acre-foot - the volume of water that would cover 1 acre to a depth of 1 foot; 43,560 cubic feet or 1233.5 cubic meters.*

Investigations in Water Properties

I. Hard Water/Soft Water Experiment

You have probably heard the terms “hard water” and “soft water.” Perhaps you or someone you know has a water softening service in their home. Most likely, you have wondered how a liquid could be described that way. In the following experiments you will have the opportunity to discover the difference between hard and soft water, and you will be able to create samples of these waters.

To discover the difference between hard and soft water, obtain two water samples, one from a stream*, the other should be rainwater or distilled water purchased from the grocery store. Place equal amounts of stream water and rainwater (or distilled water) in each of two clear glass jars (small jam or jelly jars or baby food jars work well for this).

Carefully add liquid soap (dishwashing soap) to the stream water, one to two drops at a time. Between each addition of soap, cap the jar and shake it well. Write down the number of drops of soap you add each time. Repeat this action until a 1 cm thick layer of soapsuds forms on the surface of the water. Record all observations.

Perform this same procedure on the rainwater (or distilled water), carefully keeping track of the number of drops of soap needed to produce the 1 cm layer of soapsuds. Record all observations.

Analysis and Conclusions:

1. Which water sample (stream or rainwater/distilled water) do you think is hard, and which one do you think is soft?

2. How can you support the answer you gave in question number one? In other words, why, based on your observations, did you identify one water sample as hard and one as soft?

3. In the water sample that you decided was hard, what do you think the water contains that the soft water sample does not? Think about where the water samples came from, this will give you a clue.

** Stream water can be simulated. See next page.*

Hard Water/Soft Water Experiment – Background Information for the Teacher:

Hard water is different from soft water in that it contains minerals. Stream water (hard water) will naturally have a higher concentration of minerals than rainwater (or distilled water you purchase at the grocery store). Soapsuds are more easily made in soft water than in hard water. Your students will probably ask questions about doing laundry in different types of water. Guide them in coming to the conclusion that all waters are not the same and that soft water is better for creating soapsuds. Have the students demonstrate this to themselves by trying to remove a grease stain from a piece of cloth using both water samples containing the soapsuds (which they made earlier). Each student or group of students will need two small scraps of cloth with a smudge of cooking oil, fat or Vaseline.

If you do not have access to stream water for this experiment, you can make your own hard water by dissolving a rounded teaspoon of calcium sulfate (plaster of Paris from the home improvement store) in a liter of distilled water. You can also create hard water by dissolving a rounded teaspoon of magnesium sulfate (Epsom salts from the grocery store) in a liter of distilled water.

An extension to this experiment is to soften water by boiling or with a chemical. Take a hard water sample and boil it. Cool the sample and distribute some (a small jar's worth) to each student or student group. Have them repeat the soapsuds-making test. Then have the students take a hard water sample and add a pinch of Boraxo soap (available at the grocery store) and repeat the soapsuds test. The students should discover that both boiling and a chemical treatment can soften water, as they will observe that the formerly hard water can now more easily make soapsuds.

Finally, have the students bring in tap water samples from home and repeat the soapsuds test. They may be surprised to discover that water treatment varies in certain parts of a city and not all of the students will have the same quality of softness or hardness in their tap water.

II. The Universal Solvent

Water is often referred to as the "universal solvent." What this means is that many substances can be dissolved in it. This is important in our environment, as it allows nutrients to be made available in the soil or to flow into plants and trees. It is also critical for reducing pollution as harmful substances can be broken down or diluted by water. Our own bodies are also dependent on this process to bring nutrients into our blood stream and dilute toxic substances. In this experiment, we will discover which types of substances can be broken down or diluted by water.

Obtain six small beakers or jars of room temperature water. Your teacher will supply you with six different substances, some solid and some liquid. Drop a substance in each of the six jars. Do this one at a time so that you have time to observe and record your observations.

Analysis and Conclusions:

1. List each substance you dropped into the water.

2. Next to each substance you listed, state "dissolved" or "not dissolved."

3. What lead you to the conclusions you made in question number two?

The Universal Solvent – Background Information for the Teacher:

The substances to test can be almost anything you have available from home. You will want to use only safe solids and liquids. Suggested substances include: vitamin tablets, cooking oil, milk, food coloring, juice, salad dressing, water-based paint, oil-based paint, crackers or cereal.

Have the students create a table or data collection page. The students should be able to identify those substances that can be dissolved by water and write down observations such as: the color of what was put in the water, (paint, food coloring, etc.) became lighter, the cereal broke down and the cooking oil did not mix in the water. These observations would serve as their justifications for stating, "dissolved" or "not dissolved."

III. Temperature and Its Effect on Mixing

In this experiment we will investigate whether or not the temperature of water has an effect on the rate at which a substance dissolves in water. Obtain three small, clear containers of water. One should be cold, one at room temperature and the third one should be warm. Next, place a drop of food coloring in the cold water. Time (in seconds) how long it takes for the food coloring to mix into the water. Record this time on your data collection sheet, next to where you wrote down "cold water." Repeat this process with the room temperature water and the warm water. Be certain to record any observations you make.

Analysis and Conclusions:

1. Which temperature of water allowed the food coloring to mix the fastest?

2. How would you describe the mixing (or dissolving)?

3. Where in nature do you think mixing might occur and what would be the effect?

Temperature and Its Effect on Mixing – Background Information for the Teacher:

An increase in temperature will speed up the mixing of substances in water due to increased molecular motion. Students will perhaps come up with ideas about this occurring in lakes and oceans, or perhaps you will need to prompt them.

Mixing in aquatic environments is essential for the health of the habitat as nutrients and gases need to be well dispersed. Long periods of cool weather or a change in ocean currents (such as during an El Niño) can radically impact the aquatic environment when mixing does not occur.

Investigations in Agriculture, Filtration and Power Generation

I. Run-off: From the Fields to the Water Supply, How Pollutants Travel

Have you ever wondered what happens to all of the pesticides and herbicides that are sprayed on agricultural crops when the crops are irrigated or when it rains? In this experiment you will model what happens by setting up a demonstration. It would be unsafe to use actual pesticides or herbicides in this demonstration, so we will substitute by using a vinegar solution.

Obtain a copy paper box lid or similar container. If you use a copy paper box lid, line it with aluminum foil. This will not be necessary if you use a plastic container.

Next, add soil (either from the school yard or commercial soil mix from the garden center store). This will be your model "field." While it is not essential to the demonstration, you could plant your own "crop" of plants. You would need to plant several rows of any inexpensive plant. Or, if you have time and a little patience, plant radish seeds and let them sprout. You can speed up the sprouting by placing the model field in a warm area of the classroom. Once the seeds sprout, make certain there is ample light available (it will take about 10 days to get a "crop").

Obtain a small bottle of vinegar (available at the grocery store). Vinegar is an acid. This will be the model pollutant (either pesticide or herbicide). Use pH paper, which your teacher will provide, to determine the level of acidity. Your teacher will explain how to use the pH acid test paper and what the color change on the pH paper indicates when it is dipped in the vinegar.

Record the number (it will be less than 7) that corresponds to the pH paper color chart. Be certain to identify that the number you just wrote down is the acid level for vinegar.

Take your model field out of doors. Now, liberally water your "field" with the vinegar. While the vinegar is soaking into the soil of your model field, obtain a sprinkling can. Fill it with tap water. Use the pH paper to check the acid level of the water. You should note that the acid level is actually neutral, with a reading of 7.

Now you will make it rain over your "field." As the water runs over the edge of the model field, use the pH paper to check the acid level of the run-off water.

Analysis and Conclusions:

1. What was the acid level of the vinegar? What was the acid level of your "rainwater?"

2. What was the acid level of your "run-off" water?

3. How did your demonstration show pollutants entering our environment?

Run-off: From Fields to the Water Supply, How Pollutants Travel – Background Information for the Teacher:

Your students should be able to determine that irrigation and rain carry excess pesticides and herbicides into our environment. Guide them in a discussion of where the water from run-off goes. They may not understand the storm drain system and the fact that everything that runs into the storm drain ends up in the ocean. It would be beneficial to actually walk the students out to the curb and discuss this by the storm drain nearest to your school site.

It is not important at this time that they fully understand the pH scale. (We simply used a weak acid as a model for a liquid pollutant that was easy to identify with pH paper). Simply point out that the color change on the pH paper corresponds to a number on the pH paper package. By matching the color of the paper to the chart on the package, they will see a number. This number represents the acid level. Lower numbers indicate acids, a reading of “7” indicates neutral (not acid, not base) and numbers higher than 7 indicate bases or alkalines (the opposite of acids).

II. Build a Water Filter

Filtering is one way we clean water to make it usable. You can make a filter of your own and test it to see if it actually can clean up dirty water. All you need is a plastic soda bottle with the bottom cut off. Use modeling clay to make a stopper for the bottle. Use a pencil to poke a hole in the clay stopper. Cut a four-inch piece of plastic soda straw and fix it securely in the stopper hole. The straw should extend just inside the neck of the bottle in which you insert the stopper.

Now you will need a partner. While one of you holds the bottle upside down, the other of you will place the following items in the bottle. Please place them in this order: several cotton balls or wadding, three inches deep of small pebbles, two inches deep of coarse sand, two inches deep of fine sand, about an inch deep of charcoal paste (which your teacher has prepared for you).

Next you will need to obtain a bottle of muddy water. Hold your filter over a large plastic drinking cup or a glass jar. Pour most (but not all) of the muddy water into your filter. Catch the water, which has run through the filter, in the cup or jar.

Analysis and Conclusions:

1. Describe the muddy water prior to pouring it into the filter (you should have retained some of this water for this purpose).

2. Describe the water from your filter that was collected in the cup or jar.

3. Was your filter effective in cleaning the muddy water? Support your answer.

Build a Water Filter – Background Information for the Teacher:

To make the charcoal paste for this activity, grind some wood charcoal and add water to make a paste. To save time and materials, have the students make small filters out of individual size soda or water bottles.

Your students should have fairly good success in cleaning the muddy water with their filters. Guide them in discussions about water treatment and why it is so important. Let them know that the natural environment acts as a filter and that organs in our own bodies, such as kidneys and our liver, act as filters.

Your students may want to create other filters with different materials such as a coffee filter, paper or paper towels. The reason that some materials are caught in filters and some are not has to do with molecular size.

III. Build a Waterwheel

Waterwheels have long been used to perform work. Running water over a wheel attached to an axle is a method for creating a turning action. The earliest waterwheels were Greek and were used in the first century BC in mills to grind grain into meal. Another example of the use of the waterwheel is the paddle wheel boat. Waterwheels have also been used to press fruit into cider and old fashion cider mills are still in operation in many places.

In modern times running water has been used to generate electricity in hydroelectric power stations using the same principle as the waterwheel. In this case, powerful rushing water from a reservoir enters the blades of a turbine (it is shaped like a wheel and looks much like a fan turned on its side). As the water flows into the turbine it turns and in doing so, moves a generator shaft (like a car axle) in the center of the turbine. This shaft is connected to the electricity generator, and electricity is then distributed to the power lines. As you can imagine, having an ample supply of water is critical for this type of modern power generation.

To build your own model waterwheel you will need to gather a few materials. Be creative and use whatever is readily available to you. Select an item to serve as your axle. Even a pencil would suffice.

Next you will need to locate something to act as the wheel, perhaps you can locate an old thread spool or some other item that would otherwise just be discarded.

Now you will need to find some type of material out of which you can create blades (even heavy cardboard would work), which you will attach to your wheel. The blades are critical to the efficiency of your working waterwheel as it is the blades that catch the running water and turn the wheel. This is quite a design challenge, as you will have to find a way to attach blades to the wheel. You may want to do a little research in the library or on the Internet to see how working waterwheels have been constructed.

Once your wheel is complete, go outside with a partner and gently pour water over your wheel and see how efficiently it turns.

Analysis and Conclusions:

1. Did your wheel turn smoothly? If not, what could you change to make the action smoother?

2. What was your biggest design challenge?

3. With what you currently know about the workings of the waterwheel, could you design a simple apparatus that could be run by the action of your waterwheel? It would not have to be complex or elaborate, it would just need to be able to move or turn something attached to the axle. Give it a try!

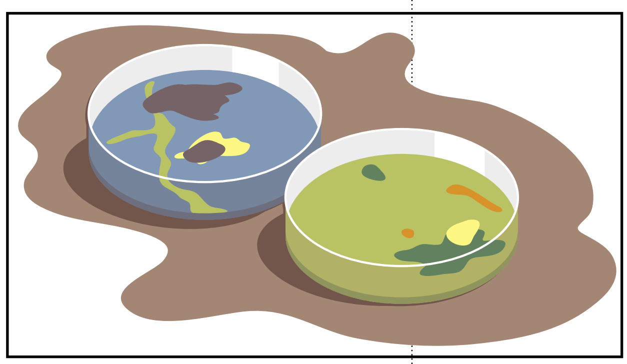
Background Information for the Teacher:

Gathering pictures of waterwheels and providing them for your students will aid them in their designs and construction. Allowing the students to experiment with several types of materials and a variety of items will sharpen their design skills and allow for creative expression.

Investigations in Sanitation, The Potable Water Supply

I. Culturing Water Samples for Bacteria

Every year between five and ten million people die from water-related diseases. As water becomes more scarce, the likelihood of disease increases. Using water wastefully, pollution, and the depletion of wells and springs all contribute to the chance of water-related diseases occurring. Close to its source water is clean. As water is used it picks up other substances such as fertilizers, pesticides, herbicides, and live, disease- causing agents such as bacteria, viruses, and fungi. In the following experiment you will grow colonies of bacteria found in various water samples you collect.



For this experiment you will need four petri dishes containing nutrient agar (a gelatin food source on which to grow, or culture bacteria). You will also need a sample of pure, clean water (such as bottled water from the market, distilled water will do), and three dirty water samples from three different sources. Use clean containers (such as individual size drinking water bottles (one for each sample) to collect the water. Be certain to label the clean water as "clean" and label each of the other three bottles by stating the source from where the sample was taken.

To collect water samples, you might select the dinking fountain at your school site, a puddle of standing water somewhere on the school grounds, and perhaps water running along the gutter. Wash your hands after collecting the samples.

Finally, you will need four, clean cotton swabs, one swab will be used to place one water sample in one petri dish. Use a waterproof marker to label the bottom or edge of each petri dish with the water source.

Lift the lid slightly on the petri dish marked "clean water" (just enough to be able to slip in the cotton swab). Now take one of the cotton swabs and dip it into the clean bottle of water. Gently swab back and forth on the agar in the petri dish you marked as "clean." Be certain to keep from poking a hole in the agar with your swab. Replace the lid to the dish promptly and seal the edges with tape. Repeat this process with the three dirty water samples. You will use a new swab for each water sample.

You can now turn each of your four petri dishes up side down, stack them and tape them together with clear or masking tape. Place your stack of dishes in a warm place (inside a drawer will suffice) and wait for 24 to 48 hours. Prepare a data table, which states the location from where the water samples were collected. Be certain to include your "clean water" sample, as this is the control for your experiment.

After 24 to 48 hours, you will see clumps or clusters of bacterial colonies. You can now count the colonies to determine which location had the dirtiest water.

Analysis and Conclusions:

1. Did your clean water sample have any colonies of bacteria? If so, why do you think bacteria might be in a "clean" water source?

2. Which sampled location had the dirtiest water?

3. Out of all of the locations sampled by all of the students in your class, which one grew the greatest number of colonies? Why do you think this source had the most bacteria and what, if anything, could be done to clean up that water source?

Culturing Water Samples For Bacteria – Background Information for the Teacher:

To obtain plastic petri dishes pre-poured with nutrient agar to conduct this investigation, contact Carolina Biological Supply at <www.carolina.com> or at 1/800-334-5551. If you prefer, you can order empty petri dishes from Carolina Biological Supply and make your own agar from scratch. The recipe follows:

Boil some rice or potatoes in a pot until well cooked.

Use the rice or potato water to prepare some unflavored (such as Knox brand) gelatin (follow package directions).

Add a pinch of salt and a little beef broth or bouillon (about a tablespoon) to the gelatin and stir the mixture. If your broth or bouillon contains salt, omit the pinch of salt.

If you do not have or want to purchase petri dishes, you can substitute with clear, plastic sandwich boxes (used for take-out food) available from a restaurant supply store.

Whether pouring agar into a petri dish or clear plastic sandwich box, be certain to fill the container to a depth of 3 to 4 mm.

Once the gelatin has solidified, turn the containers up side down and place them in the refrigerator for future use. Keeping them up side down prevents the collection of condensation on the agar.

Your students should be able to make determinations about the levels of bacterial growth found in their water samples by simply counting the number of colonies that appear in the petri dishes. The colonies will appear as cloudy, clumpy masses.

Be certain that the petri dishes (or sandwich boxes) are not opened once they have been sealed with tape. To safely dispose of the bacterial cultures you may do one of two things: 1) microwave them in a microwave oven; or 2) briefly open the dishes and pour household chlorine bleach on them. Now the cultures are dead and may be put in the trash.

II. Drinking Water Requirements

Have you ever wondered about the quality of your drinking water? Did you know that before your water comes out of the tap it goes through a series of treatments? What if the water were not treated, what impacts might it have on the quality of our lives?

In this research exercise, you will discover the path water takes from the time it falls as rain to when it reaches your tap. You will need to prepare a presentation in any format you choose: poster, video or PowerPoint.

In order to collect the information you will need for your presentation, you will need to first understand the basics of water treatment and what the water quality standards are. Use your school library and the Internet to find out where water is collected and saved for future use, how it gets to the treatment plant and what occurs at the treatment plant.

Once you have this basic information, contact your local sanitation district and your local water district (your teacher will provide the phone numbers for you) and interview a representative from each of these two organizations. Finally, research water-related diseases to find out what can happen to human health when water comes in short supply or is not properly treated.

Once your presentations are complete, work with your teacher to locate a place on campus, such as the library, where your presentations can be displayed for others to become informed consumers of this precious resource.

Drinking Water Requirements – Background Information for the Teacher:

You may want to do a little background research on water treatment and water quality standards before you begin this project so that you can offer frequent and informed feedback to students as they prepare their presentations. Also, be certain to collect the phone numbers for the local water and sanitation districts to give to your student researchers. It would be advantageous to divide the class up into research teams, and have each team focus on one particular area.

The presentations can take any form. The students can create their own mini-episode of a program such as seen on the Discovery Channel, do a PowerPoint presentation or create a poster display like ones you would view at a science museum.

This project will probably take two to three weeks to complete. Once the presentations are complete, find out if there is a place on campus for a public exhibition of the students' work.

III. Bottled Water Versus Tap Water

In this investigation, you will survey the public on the trendy practice of drinking bottled water. You may have noticed that the grocery store shelves are full of many brands of bottled water, and you probably see a lot of people throughout your day drinking bottled water. In addition, you have no doubt seen water vending machines outside of grocery stores where people can purchase water and bottle it.

Ever wonder when the last time the filter in the water vending machine was changed? By now you know quite a bit about water treatment and water quality standards.

Design a short questionnaire (about 5 questions), and interview no less than 20 people. Make note of the age (approximate, such as elementary school, middle school, high school, young adult, middle aged or senior adults) and gender. It might be very interesting to see if more of one gender prefers bottled water or what age groups drink the most bottled water.

The questions you design should be quick to answer, as you will be doing this in an interview format. Determine what you, as a researcher, want to know about the public's perception of drinking bottled water versus tap water and why.

Once you (or your research group) have completed collecting the survey data, tally it and present your findings. Ask if your school newspaper will publish your findings.

Bottled Water Versus Tap Water – Background Information for the Teacher:

This investigation gives students the opportunity to sharpen their verbal and written skills as well as their math skills. Depending on the grade level and ability level of your students, decide on how best to guide them in the analysis of their data.

Younger students can present their data as, "10 out of 30 people interviewed...," whereas older children should be able to determine actual percentages. This is also a great way to teach fractions and percentages, as students are generally more interested in working with data they collected.

Investigations in Irrigation

I. Soil Types and Watering Systems

Watering plants and lawns is just watering plants and lawns, isn't it? Well, probably not. There are many factors to consider if we are going to conserve water and use it wisely. If this were not true, then why are there so many different kinds of sprinkler and watering systems available on the market?

In this experiment you will be looking at three different soil types and three different watering systems to determine what type of watering mechanism is best for certain types of soil.

Obtain the following soil samples and place one of each in an aluminum pie pan: 1) school yard soil; 2) potting mix; 3) school yard soil mixed with an equal amount of sand. You will need three sets of these soils so that you can test three different watering systems on each.

Next, create three different watering systems. One could be just a container of water that you pour (to model watering with a hose), another could be a spray bottle (to model a mist system) and the third could be a turkey baster (to model a drip system).

How effective each type of watering system is on each type of soil will be determined by how readily the water soaks into the soil. After all, this is the goal of watering or irrigation—to get water to the roots of plants.

Make a chart to collect your data. You will need to list the soil types on the left side of your paper and the watering systems along the top margin of your paper. You will probably want to use a ruler to draw columns and rows on your paper so that you can easily fill in your observation on each watering system used on each soil type.

Analysis and Conclusions:

1. How would you describe your schoolyard soil as compared to the potting mix and the soil sample you created by mixing sand with the schoolyard soil?

2. Which watering system produced the least effective soaking of which soil types (in other words, took a long time to soak in)?

3. Which watering system produced the most effective soaking of which soil type?

Soil Types and Watering Systems – Background Information for the Teacher:

For this experiment you will probably want the students to work in groups and to work outside. Guide them in creating neat data collection tables to record their observations.

II. Too Much of a Good Thing, the Effects of Over-Watering

It is possible to over water plants. This is not good for the plants and it certainly does not help us in our goal to be good water conservers. One of the early signs of over-watered plants is the yellowing of the leaves. Following the yellowing is "leaf drop", meaning that the leaves fall off. Eventually the plant dies.

Why does this happen? The answer lies in the fact that oxygen must be present around roots. When the soil is full of water all the spaces between the soil particles are filled with water and there is no available oxygen for the roots of the plant. The roots essentially "drown." The roots are no longer capable of absorbing nutrients. Over time if the oxygen level in the soil remains low, harmful organisms continue to live, producing harmful, toxic substances, beneficial bacteria die off and the roots become susceptible to fungal diseases. All of these conditions contribute to the yellowing of the leaves, leaf drop and the eventual death of the plant.

To determine an appropriate water level for a plant, obtain three small potted plants, all of the same species, size, and planted the same way in the same size and type of pot (a four inch pot is suggested). Select a location for your plants. You will need sunlight, so locate a space near a window or conduct your experiment outside.

Determine a watering schedule for each of your three plants and the amount of water you will use each time on each plant (it must be the same for each watering and for each plant). One watering schedule should be very frequent, one moderately frequent and one very infrequent. Remember, each time you water your plants you need to use the same amount of water on each plant. By doing so, your experiment has only one variable and that variable is time (frequency of watering).

Record your watering schedule (the amount of water and the date of each watering for each plant) and all observations you make on your plants.

Analysis and Conclusions:

1. What amount of water did you use each time? What was the watering schedule for each of your three plants? What plant species did you use?

2. Describe the condition (the look) of each of your plants.

3. What was the optimum watering schedule?

Too Much of a Good Thing, the Effects of Over-Watering –

Background Information for the Teacher:

For this experiment you may want the students to work in groups, dividing up the watering responsibility and data recording over the duration of the study. Plan on a week to two weeks to complete the investigation.

III. Irrigation at My School Site

It would be interesting to determine how much "rain" a lawn sprinkler at your school site produces. This is simple to do. Obtain five empty coffee cans. Number the cans one through five. Place can number one nearest the sprinkler head, followed by number two, and so on until all five cans are in place. Be certain that the cans are spaced evenly in a line out from the sprinkler head. Turn the water on and record the time it takes for each can to fill with an inch of water.

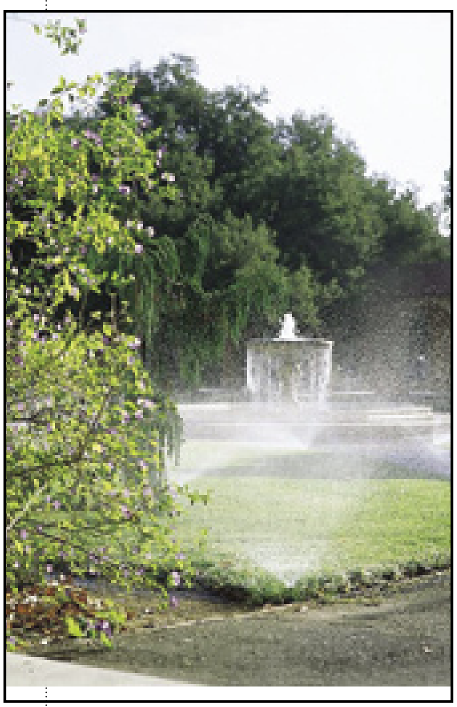
Analysis and Conclusions:

1. Which coffee can filled with an inch of water first?

2. Which coffee can filled with an inch of water last?

3. What conclusions can you draw from this experiment about how evenly the lawn is watered at your school? Does the lawn look as though it is watered evenly or unevenly? Justify your answer.

Irrigation at My School Site –



Background Information for the Teacher:

As an extension to this experiment, you could have the students fully investigate the irrigation at your school site to determine if it is efficient or if water is being wasted. They could make observations of run-off, standing water (puddles), areas of dead grass from over water or under water and identify whether the correct sprinkler types are being used. Older students could easily do library or Internet research on soil types (sand, loam, or clay) and determine how much rain (or sprinkler water) is needed to penetrate the soil to maintain a healthy lawn.

Amazing Water Facts*

- Each person in the United States uses approximately 150 gallons of water per day.
- Approximately 2,400 gallons of water are wasted per year by a water leak dripping at a rate of one drop per second.
- The California State Water Project (SWP) is a 444-mile long California Aqueduct, which transports water from the Sacramento–San Joaquin Delta to southern California. About 20 million Californians, or two-thirds of the state's population, get at least a portion of their water supply from the SWP.
- A ten-minute shower with a standard showerhead uses approximately 5 to 8 gallons of water per minute.
- Approximately 70 percent of the water consumed by the average household is used outdoors.
- The human body is made up of 70 percent water.
- Ninety-seven percent of the water on Earth is salt water. Of the remaining 3 percent of the water on Earth, 2 percent is trapped as glacier ice, leaving only 1 percent of all of the water on Earth that is available for all of us to use.
- Water is the only substance on Earth that is found in its solid, liquid, and gaseous states naturally.

** Courtesy of the Walnut Valley Water District, Walnut, CA*

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