Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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Think Before You Drink!

Curriculum Unit 03.05.02
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Introduction

As a past Science teacher and now in the position of Media Center Assistant, I have been able to use my past Seminar experiences to help students with their various Science Fair projects. This year, students have come to me for help with several Science Fair Projects on water. This unit focuses on the type of questions asked to me by students. Because there were a wide variety of questions, I am trying to provide information for diverse water activities. The student can then decide which water activity is of interest to them and do their investigation.

We all know students tend to become more interested when activities are available. I have included web sites, tried activities from SEPUP kits and the Regional Water Authority. By making the teacher and student aware of activities that can be used for a Science Fair Project, a major hurdle will be out of the way.

Collaboration is a focus in teaching students. This makes learning more meaningful and interesting by providing carry-over between classes. This unit will be one method collaboration between staff members can be realized and also satisfy curriculum standards. Different aspects of the project may fulfill the needs of different departments and programs.

Subject	Activity	Performance Standard
Science	Experiment	P.S. 1 Science Inquiry
Social Studies	Laws & Regulations	P.S. 4.0 Economics
Language Arts	Research Paper	P.S. 2.1
Math	Data/Statistics	P.S. 7.1

Students may also have the opportunity to work independently or with a partner on this project.

Background

We will begin the unit by having the student focus on water issues. If you have computer access, you can go online and have students take a quiz on their knowledge of water issues. If you want immediate follow-up to the quiz in the form of a short movie, use BrainPop which can be found at http://www.brainpop.com. If you

prefer not to have a movie follow-up, a true/false quiz from Water Science for Schools is available at http://www.ga.water.usgs.gov/edu/sc3.html.

Universal Solvent

To lead into water being called the “universal solvent” ask why it is not a good idea to have electrical appliances near your bath water. After a brief discussion, do a water conductivity exercise with “pure” water and several different water mixtures. The student will realize that “pure” water is a non-conductor. You can then explain that like the bath water, water is rarely in a “pure” state. Because water dissolves more substances than any other substance, it is called the “universal solvent.” This does not mean it will dissolve all substances but it can impact our drinking water system if certain materials are allowed in its path.

Water Cycle

Reinforce the fact that most of the water on earth is in the oceans and seas (97%.) Of the remaining 3% only 1% is available for drinking. It is therefore important for us to understand the responsibilities of not abusing this vital resource. Some sources say we use about 100 gallons of water each day to perform daily activities. If something should happen to our drinking water, we could only live for about 5 to 7 days without water for drinking. This chart shows how the water keeps being recycled.

(image available in print form)

We should now be in a position to allow students to pursue a topic of interest to from the following:

Regional Water Supplies

Wells

Bottled Water

Water Conservation

Regional Water Supplies

To protect our water supply, the Regional Water Authority has implemented programs that are preventative in nature. If you would like more specific information about the following programs, go to http://www.rwater.com/waterandmore/

Watershed Inspection Programs

Regional Water Authority Police Force

Source Protection Program

Waste Inspection Program

The Regional Water Authority covers Bethany, Branford, Cheshire, East Haven, Guilford, Hamden, Killingworth, Madison, Milford, New Haven, North Branford, North Haven, Orange, Prospect, West Haven and Woodbridge.

Most of our tapwater supply comes from lakes (80%) in Woodbridge, East Haven, Branford and North Branford and the balance from aquifers located in Cheshire and HamdenThe Regional Water Supply has an existing/proposed land use plan. The main areas are:

Water Supply & Facilities - 2,280 acres

Preservation Use - 3,495 acres

Recreation and Educational Use - 35 acres

(Below is a map of the recreational areas from the Regional Water Authority)

(image available in print form)

Natural Resource Uses - 14,535 acres

The Regional Water Authority sends out a yearly Water Quality Report. This report covers topic such as:

How safe is my water?

Do I need to take special precautions?

What do we do to assure your drinking water complies with federal and state

standards?

Where does my water come from?

Water quality reports for lakes and aquifers.

How can contaminants get into my drinking water?

Water Treatment and Distribution System

The Regional Water Authority for the New Haven Area has five treatment facilities. Two of the systems are for treating well water. The exact procedure for the treatment of water is not the same at all plants. This is due to the fact that not all water has the same treatment needs. Different locations (watersheds) have different characteristics due to their source water. The most common pollutants are from fertilizers and pesticides that have been used on lawns and in gardens. Fuels, solvents, oil, cars and trucks introduce other pollutants. Another source is from porous pavements that are used to prevent flooding. They inject pollutants into the groundwater. Removing vegetation during construction projects can also damage the groundwater system. Instead of moving slower and having an opportunity to penetrate into the ground, it moves much faster carrying and depositing unwanted materials in unwanted places.

Diagrams for the Distribution System and the Treatment Plant can be found in Exploring The Water World by the Regional Water Authority. The first diagram shows what happens during the distribution of water to our homes while the second shows how water is treated in the water treatment plant.

By the use of valves in the intake house, water is introduced to the water treatment plant. In the water treatment plant the water goes through the treatment process. The water is treated with coagulants to form clumps in the flocculation basin called flocs. The water is then passed through filters which strain out the flocs and other impurities. Chlorine or another disinfectant is then added to this water before it enters the storage tanks. From the storage tank it is sent through water mains to use.

The water is tested at each stage to insure the treatment is working effectively and the standards are being met. They discovered in the 1850's that water needed to be both filtered and disinfected to make it safe from bacteria. The first treatment plant to use filters was constructed in 1872 at Poughkeepsie, New York. Although chlorine is the chief agent for disinfecting water at this time, other methods are being researched that reduce some of the harmful long-term effects of chlorine intake.

There are a number of activities a student could do in the water treatment area for a Science Fair Project.

Well Water

A good way to start this topic is to use the SEPUP activity, Investigating Groundwater: The Fruitvale Story. These kits are available to all New Haven science teachers with training provided on the use of the kits. This activity has them find the source of groundwater contamination by sampling water from certain wells in the area. This activity leads to an understanding of groundwater movement and they become familiar with terms such as porosity, permeability and aquifers.

(image available in print form)

Wells can be dug in a variety of ways as you can see from the diagram taken from Water Science for Schools, Groundwater: Wells. They can be dug by hand, driven or drilled but, they all have one thing in common. They must be deep enough to stay below the water table all year long. Approximately 500,000 people use well water for drinking in Connecticut. Most of this well water is not tested for pesticides. Recently 53 homeowners volunteered to have their wells tested for pesticides. Seventy-two percent used pesticides either on their lawns and/or trees. Eleven percent of the tested wells contained trace levels of pesticides. Five of the wells had more than one pesticide present. However, this does not mean if you do not use pesticides, pesticides will not contaminate your well. If you performed the Fruitvale investigation, the student will better understand how these underground formations differ in supplying water for a well. These underground formations are also the reason why some wells run dry each year while the neighbors well does not have a problem.

Well water in Connecticut frequently has problems such as hardness, taste, odor and staining which are objectionable to the user. Filter screens on faucets may also become clogged with debris from the well. The good news is that having some sort of filtration system installed probably can solve these types of problems.

Your well water should be tested periodically for nitrate and coliform bacteria. If contaminants are present and they exceed the standard, contact the Public Health Department for assistance.

There are a number of steps one should take if they are using a well for their water supply. The following is a list of suggestions taken from the website: http://www.epa.gov/safewater/pwells1.html

- Periodically inspect exposed parts of the well for problems such as:

- cracked, corroded, or damaged well casing. - broken or missing well cap. - settling and cracking of surface seals.

- Slope the area around the well to drain surface runoff away from the well.

- Install a well cap or sanitary seal to prevent unauthorized use of, or entry into, the well.

- Have the well tested once a year for coliform bacteria, nitrates, and other constituents of concern.

- Keep accurate records of any well maintenance, such as disinfectant or sediment removal, that may require the use of chemicals in the well.

- Hire a certified well driller for any new well construction, modification, or abandonment and closure.

- Avoid mixing or using pesticides, fertilizers, herbicides, degreasers, fuels, and other pollutants near the well.

- Do not dispose of wastes in dry wells or in abandoned wells.

- Do not cut off the well casing below the land surface.

- Pump and inspect septic systems as often asrecommended by your local health department.

- Never dispose of hazardous materials in a septic system.

If you do/did not have access to the SEPUP investigation, we should make sure the student understands what is meant by groundwater and why it is important to have a safe reliable source of groundwater.

Ground water is the source for well water. This water fills in the spaces inside the earth. The top of this underground water is called the water table. As the water table fluctuates with the seasons, it is important the well be deep enough to always be below the water table.

Approximately 50% of the people use groundwater for drinking. Groundwater moves through what we call aquifers (spaces in soil and rock.) The speed at which the water moves depends on the size of the spaces and how they are connected. If the material above the aquifer is permeable, then it is easier for pollutants to enter the system.

The main means wells become polluted are from landfills, septic tanks, leaky underground gas tanks and over use of pesticides/fertilizers.

Congress originally passed the Safe Drinking Water Act in 1974. This Act was put in place to protect the public by regulating the nation’s public drinking water. Maximum contaminant levels (MCLs) have been put in place for our drinking water. Secondary MCLs are also used to control odor, taste and appearance. However, these standards do not apply to water supplies that do not have at least15 connections.

Remember there are some naturally occurring pollutants to our groundwater system that we might not be aware. Remember it your responsibility to insure your well water is safe too drink for you and your family.

Here are some tips taken from: http://www.msuc.edu/genescc/natres/groundwater.htm

1. Recycle - Less chance of polluted water entering the well.

2. Use native plants for landscaping- Adapted to climate and pest, less need for fertilizers and pesticides.

3. Plug up unused wells.- Prevents contaminants from entering groundwater system.

4. Use good fertilizer practices.

5. Divert and/or contain stormwater.

Bottled Water

The Food and Drug Administration classifies bottled water into seven different categories. Of these seven, we will concern ourselves with drinking water.

We know that we should drink between 6-8 glasses of water each day to promote good health. It is believed that some people are substituting beverages in place of water. A possible problem with this substitution might lead to dehydration by beverages that rob the body of water. These dehydrating substances are caffeine or alcohol-containing beverages. They work as diuretics causing the body to lose water by increased urination.

Before we get into the controversy of bottled water vs. tap water, let us look a chart from the web site:

http://www.nrdc.org/water/drinking/nbw.asp that show some differences with rule

(table available in print form)

Bottled water must meet all applicable federal and state standards, be sealed in a sanitary container and is sold for human consumption. This water cannot contain sweetners or chemical additives and must be calorie and sugar free.

Bottled water is a fast growing industry. Why do people opt for bottled water over tap water? If we participate in various outdoor or indoor activities, it is easier to hydrate ourselves by carrying a bottle of water than to search for a drinking fountain.

As we see from the rules, (tap water vs. bottled water) tap water may be the safer drinking source. If one looks at the frequency for testing, public water suppliers monitor their product more frequently than the bottled water sector. However, bottled water tends to be more consistent in taste and quality. Another reason may be the chemicals used in tap water. Over long periods of time chlorine may have adverse effects on some people.

As most bottled water is placed in plastic containers, we should investigate the problem of plastic disposal, the SEPUP units Plastics in Our Lives might be appropriate to do at this time.

If he/she decides to develop a Science Fair Project on bottled water, they should investigate the pros and cons and the history of this industry.

Water Conservation

This activity may make the student more receptive to conservation practices. Ask them how much money they would receive if every person in New Haven gave them one dollar. They would receive about $125,000.00. This should make them realize that if everyone did just a little to conserve water, big savings would be the end result

Those who would like to proceed with a water conservation project might start with family members in their households. The age level will help determine the type of project and sophistication. But, what is good about this is that all family members are involved in the project and from my experience, generally helps the family unit.

If possible, record the reading from your water meter at the beginning of the week. During the week have your family members complete a water use analysis chart each day for that week. At the end of the week read and record the water meter reading. Evaluate the water use from your water use chart and discuss ways with your family that you might conserve water.

Using the ways you plan to conserve water, repeat the investigation. We must realize that there may be many variables with this investigation but it serves the purpose of gathering and interpreting data and makes the family aware of the importance of conservation.

Fun Demonstrations

Before we end this unit on water, we should do one or two demonstrations for the students with water. Ending with an activity or two might motivate them to think more seriously about an experiment/demonstration for their project.

I have found that discussing the formula H2O and then the equation:

2H2O--->2H2+O2,

is an activity of great interest to the student. The electrolysis of water demonstration gives the student an opportunity to see visually what we have been discussing. This activity can also be expanded to show how to test for the gases hydrogen and oxygen. If your electrolysis apparatus has petcocks at the top of the tubes, you can collect the gases in a test tube for testing. You might want to explain to your students this is called a decomposition reaction.

Another investigation can be done to show what is meant by a reversible equation and how the displacement method is used to collect gases. You may want to tell the student this is called a synthesis reaction.

2H2 + O2--->2H2O

In this demonstration, you fill a coke bottle with water. You then displace 2/3 of the water with hydrogen gas and displace the remaining 1/3 with oxygen gas. You cork the bottle so the gases will not escape and wrap a

towel over the end of the bottle. You remove the bottle from the water, in front of an open flame (DO NOT HAVE BOTTLE POINTING AT ANYONE) remove the cork. A loud explosion occurs. Although no visible amount of water is formed, it is entertaining to the student and they do learn how to use the displacement method for collecting gases and generally remember what is meant by a synthesis reaction.

I would suggest that the teacher perform this investigation for safety reasons. If you decide to do this demonstration, the procedure for generating the gases will be your decision.

We can then go on to discuss that water can be found as a gas, liquid and solid in the same place. Have students give examples of this phenomenon. If you would like to get some practice constructing data tables and graphing results, this can be accomplished by making a data table for changing water from the freezing point to the boiling point. Record the temperature at set time intervals. When the students graphs their results, they see that this is not in a straight line but has plateaus. You may briefly talk about the heat of fusion but I would not spend a great deal of time with this area.

Think Before You Drink

We are very fortunate in the United States that we have one of the safest water supplies in the world. In Connecticut, we get about 32% of our water from groundwater and 68% from surface reservoirs. We must remain vigilant in our protection of watershed areas. Profit sometimes causes unwise decisions to be made with water shed lands which may harm the water supply.

We are told to drink from 6-8 glasses of water each day but, as we drink our daily allotment of water, we must be aware of the potential dangers that may be present. We must be aware that some possible long-term effects may result from making our water safe to drink. We must also be careful about the amount of alcohol and caffeine consumed as they can deplete water from our bodies.

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Lesson Plan I - Teacher Demonstration

Electrolysis of Water

What Do I Want To Do?

I want the student to see visually what is meant by the formula H2O equation:

How Well Do I Want To Do It?

Upon completion of the demonstration, I want the student to visually see the different the level of water in each tube.

How Will I Do It?

I will use a Hoffman Apparatus, water and sulfuric acid mixture (have the Chemistry Department do this for you,) a red and a black alligator clip, a nine volt battery and safety glasses.

(image available in print form)

1. Set-up the electrolysis apparatus.

2. Open petcocks to allow air to escape and get an even distribution of the water & sulfuric acid mixture.

3. Pour mixture into the center tube until the tubes are about ¾ full.

4. Close petcocks.

5. Attach the black alligator clip to the wire extending from the base of one tube and then to the (-) terminal of the battery.

6. Attach the red alligator clip to the wire extending from the other tube and then to the (+) terminal of the

battery.

7. Observe what is happening each tube.

8. Allow sufficient time for the demonstration to work. (about 2 class periods)

Write the equation

$2H_2O \rightarrow 2H_2 + O_2$

9. Discuss what happened during the demonstration.(decomposition rxn)

How Will I Evaluate What I Have Done?

The student should be able to correctly identify which side of the apparatus contains the hydrogen gas and which side contains the oxygen gas.

Lesson Plan 2 - Change of State

What Do I Want To Do?

Show the student what happens to the temperature of ice water as we change it to liquid water and then to boiling water.

How Well Do I Want To Do It?

Have the student realize that temperature does rise steadily when changing state.

How Will I Do This?

(Before class the teacher should time how long it takes for the ice water to reach the boiling point. The time will depend o your heat source. You can then tell the student what time intervals you want them to use for their data table.)

1. Have the students add ice to their water and stir gently, do not use the thermometer as a stirrer.

2. Record the temperature on the data chart when it appears the temperature will not go any lower.

3. Place the ice water over your heat source and record the temperature in your data table at the selected time intervals.

4. Using your data table construct a line graph.

How Will I Evaluate What I Have Done?

If their graphs looks something like the one below, then they have satisfied the goal.

(image available in print form)

Lesson Plan 3 - Conductivity of Water

What Do I Want To Do?

I want to show that “pure” water is a poor conductor of electricity.

How Well Do I Want To Do It?

I want to show them that water is rarely “pure” in nature.

I want them to realize why it is important not to electricity appliances or machinery around water.

How Will I Do This?

Using a meter, I will test seawater, river water, tap water, rain water (if possible) and distilled water.

How Will I Evaluate What I Have Done?

Ask the student, “Why was a man recently arrested for fishing in a thunderstorm with his child?”