6-8 Water Quality Activity

South Carolina Aquarium

Overview

Focus Question
What is water quality? How is it determined?

Activity Synopsis
Students will learn about water quality by testing the pH, temperature, dissolved oxygen and salinity of water samples in the classroom. Students will then determine the water quality of a local body of water.

Time Frame
Three 45-60 minute sessions

Objectives
The learner will be able to:

- Compare substances to distinguish between acids and bases
- Describe the water quality of a local body of water using the following attributes: pH, salinity, temperature and dissolved oxygen.

Student and Teacher Key Terms

- Water quality
- pH
- Salinity
- Current speed

Standards

South Carolina College- and Career-Ready Science Standards 2021

6th Grade: 6-ESS2-4
7th Grade: 7-LS2-1, 7-LS2-2, 7-LS2-4, 7-ESS3-3
8th Grade:

***Bold standards are the main standards addressed in this activity**

6th Grade Performance Expectations
6-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

7th Grade Performance Expectations
7-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
7-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
7-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
7-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Cross Curricular Standards

South Carolina College and Career Standards for Social Studies
6.5.CX, 7.5.1.PR

South Carolina College and Career Standards for Math
6.RP.1, 6.RP.2, 6.RP.3, 6.EEI.9, 7.RP.1, 7.RP.2, 7.RP.3

South Carolina College and Career Standards for ELA
Inquiry (I) – 6-1.1, 6-3.1, 6-3.4, 7-1.1, 7-3.1, 7-3.4, 8-1.1, 8-3.1, 8-3.4
Writing (W) – 6-1.1, 6-2.1, 6-4.1, 6-5.2, 6-6.1, 7-1.1, 7-2.1, 7-4.1, 7-5.2, 7-6.1, 8-1.1, 8-2.1, 8-4.1, 8-5.2, 8-6.1
Communication (C) – 6-1.1, 6-1.2, 6-1.3, 6-1.4, 6-2.1, 6-2.4, 7-1.1, 7-1.2, 7-1.3, 7-1.4, 7-2.1, 7-2.4, 8-1.1, 8-1.2, 8-1.3, 8-1.4, 8-2.1, 8-2.4

Common Core Math Standards
6.RP.3a, 6.NS.5

Common Core ELA Standards
Reading Informational Text – 6.7
Writing – 6.1, 6.2, 6.7, 7.1, 7.2, 7.7, 8.1, 8.2, 8.7
Speaking/Listening – 6.1, 6.2, 6.4, 7.1, 7.2, 7.4, 8.1, 8.2, 8.4
Language – 6.1, 6.2, 6.3, 7.1, 7.2, 7.3, 8.1, 8.2, 8.3
Reading for Literacy – 6-8.7, 6-8.8
Writing for Literacy – 6-8.1, 6-8.2

Background

Key Points
Key Points will give you the main information you should know to teach the activity.

- **Water quality** is the chemical, physical and biological properties of water that affect the living things able to use the water. It can be determined by looking at many factors including temperature, salinity, pH and dissolved oxygen content.
- **pH** is a measure of how acidic or how basic a water solution is. It is measured on a scale of 0 to 14 with numbers below 7 being acidic and numbers above 7 being basic.
- **Salinity** is a measure of how much salt is dissolved in the water. It is usually measured in parts per thousand (ppt). For example, the ocean has a salinity of 35ppt. This means there are 35 mL of salt dissolved in every 1000 mL of ocean water.
- Dissolved oxygen content refers to the amount of oxygen molecules dissolved in water. It is expressed as a percentage. Water with 100% dissolved oxygen is completely saturated with oxygen and water with 0% dissolved oxygen has no oxygen.

Detailed Information
Detailed Information gives more in-depth background to increase your own knowledge, in case you want to expand upon the activity or you are asked detailed questions by students.

Water quality includes the chemical, physical and biological properties of water. The water quality of a body of water affects the type of life found there.

A water molecule, H2O, is composed of two hydrogen atoms and one oxygen atom. When water dissociates or separates it forms H+ and OH-.This process is known as ionization. The hydrogen ion, H+, has a positive charge because it lost an electron, while the hydroxide ion, OH-, has a negative charge due to its gaining an electron. When another substance that ionizes is added, acids and bases are formed. An acid is created when excess hydrogen ions are present while a base is formed due to extra hydroxide ions. To determine if a substance is acidic or basic, the pH should be determined.

pH is a measure of the hydronium concentration in a water solution. The pH range is 0 to 14. If the solution contains more H+ ions it is acidic while one containing more OH- ions is basic.

0----------7----------14
most acidic neutral most basic
(H+>OH-) (H+<OH-)

pH can be measured using a variety of methods. pH paper is often used and is simple. There are indicators like phenolphthalein and bromthymol blue, as well as, foods that change colors in the presence of acids and bases.

The pH is one attribute that determines the biotic characteristics of a body of water. Most plants can tolerate a pH range of 6.5 to 13 while a large variety of animals prefer 6.5 to 7.5. For this reason, when the pH drops below the ideal level, many plants and animals become stressed and may die.

Temperature is another attribute that determines the biotic characteristics of aquatic habitats. The temperatures of mountain streams are dramatically different when compared to reservoirs and rivers in other regions of the state. Animals have adapted to different habitats and have specific temperature needs. For example, brook trout prefer water temperatures between 54 and 60 degrees Fahrenheit while menhaden prefer salt water with a temperature range of 59 to 68 degrees. If temperatures vary from the ideal, animals can become stressed.

Salinity is the third attribute that has a profound effect on plants and animals. Salinity is the amount of dissolved salts in water and soil. It is measured as the concentration of dissolved salt in milligrams per liter and may be expressed in parts per thousands (ppt or 0/00). The average salinity of the ocean is 35 0/00. The salinity varies near the mouths of rivers where there is the presence of freshwater. It also varies in areas of increased evaporation.

Students frequently ask how salt enters the ocean. As the rivers flow across the land, they pick up salt from the rocks and soil they pass over and carry it until it is then deposited into the ocean. Salt is also added from the sea floor. As evaporation occurs, freshwater is removed leaving salts behind which increase the salinity.

Plants and animals living in the estuaries and salt marshes of South Carolina can tolerate dramatic changes in salinity due to tidal changes that occur throughout the day. Organisms that live in the deep ocean have adapted to a salinity range that is more constant than that of estuaries. Salinity is measured using a hydrometer or a refractometer. Hydrometers may be purchased at local aquarium supply stores and are relatively cheap. The refractometer is somewhat more expensive and may be purchased from a scientific supply company.

Dissolved oxygen, the percentage of oxygen in water, is the fourth attribute that can affect organisms in aquatic habitats. The range varies dramatically. Some rivers contain 100% dissolved oxygen while others are almost devoid of oxygen. The organisms living in the aquatic habitats are dependent on the oxygen. Without it, they cannot survive. Dissolved oxygen can be measured in a variety of ways; dissolved oxygen kits and dissolved oxygen meters are commonly used. Both items can be purchased through a scientific supply company.

The biotic factors within an aquatic environment are also influenced by **current speed**, the rate at which the water flows, and water clarity. Current speed can be determined through the use of a biodegradable substance, such as an orange, being placed in the water and measured over a set distance. The speed or velocity can be calculated by dividing the distance the object traveled by time it took. Water clarity is related to the current speed. The fast moving streams of the Mountains and Piedmont carry larger sized sediments. When the water slows, the sediment falls out. The rivers in the Coastal Plain and coastal regions of South Carolina carry a greater sediment load, smaller particle size, than do those of the Mountains and Piedmont. The water clarity decreases as the sediment load increases. To measure the water clarity, a secchi disk may be used or you can make a light penetration apparatus using a glass jar, black construction paper and flashlight.

You may ask, “How do temperature, salinity and dissolved oxygen influence each other?” The temperature influences salinity and dissolved oxygen. When the air temperature is high, evaporation increases creating a higher salinity. This is evident around the equator. The salinity is generally higher in the Polar Regions also, due to pure water freezing, leaving a higher salt concentration in the water underneath. Temperature also influences dissolved oxygen. Cool water normally has a higher concentration of dissolved oxygen. The mountain streams of South Carolina are cool, fast moving, highly oxygenated bodies of water. Warmer water has the

tendency to have a lower concentration of dissolved oxygen.

All of these factors together influence the water quality of a body of water. What the water quality is determines what organisms will live around the body of water. As water quality changes, the animals that live around the water will change as well.

Procedure

Materials

Part 1

Mini-lab 1

- pH paper
- water
- lemon juice
- vinegar
- soda
- milk
- baking soda
- bleach
- pepto bismol
- orange juice
- detergent
- cups or beakers
- safety goggles
- Water Quality Datasheet (one per group)
- pH scale (one per group)

Mini-lab 2

- glass beakers
- salt
- water
- pH paper
- hydrometer/refractometer
- thermometer
- dissolved oxygen kit or meter
- hot plate
- safety goggles

Part 2

- pH paper
- hydrometer or refractometer
- thermometer
- dissolved oxygen kit

Procedure

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Part 1
Discuss water quality with your students. Ask them what they think water quality is. Teachers may want to use two photographs, one of a polluted stream and one of a healthy stream. Have students discuss factors that influence water quality. In the discussion focus on temperature, pH, dissolved oxygen and salinity as some of the factors that can be measured to determine water quality.

Mini-lab 1

1. Ask students if they've heard of pH. Introduce the terms acid, base and neutral. Discuss the pH scale.

2. Put students in groups of 3 or 4. Give each group a datasheet. Have students determine the pH of five household products. You may choose to use water, soda, vinegar, lemon juice, pepto bismol, milk, bleach, orange juice, detergent, baking soda or any other product that would be acidic or basic. (Mix baking soda and water to create a solution.)

3. Each group of students should be given five beakers containing the household products listed above. They should first predict the pH of each item and record it on their datasheet. Next, have them use the pH paper to test the pH of each and record their data. They should record if each substance is an acid or base. Remind students to wear safety goggles.

4. Go over the answers as a class and show them the pH chart.

Mini-Lab 2

1. Discuss salinity. Ask students what salinity is, what bodies of water should have greater salinity and where the salt comes from.

2. Still in groups, have students measure the salinity of two water samples and record the data on their datasheet. To create these samples, add 35 grams of salt to 1000mL of water (will create a salinity of 35 ppt). Mix well. To the second beaker add only 100 mL of water. Have students determine the salinity using a hydrometer or refractometer. These tools can be ordered from a scientific supply company.

3. Next have students measure the temperature, dissolved oxygen and pH of each sample and record the data.

4. Now, heat the water samples using a hot plate. Allow evaporation to take place. Have students carefully measure the salinity, temperature, dissolved oxygen and pH again. Record results.

5. Discuss why changes may have occurred when water was heated. How does temperature affect salinity, dissolved oxygen and pH?

Part 2
Using information learned during the mini-labs, have students design an experiment to determine the water quality of a local body of water. They may use a drainage ditch, stream, river, pond, etc. Students should include temperature, pH, salinity, and dissolved oxygen. Other factors such as turbidity and stream velocity may also be included. They should write a report to explain findings as the assessment to this activity.

At-home Learning and Virtual Modifications

At-home and Virtual Learning: Use the following nearpod information to choose how to complete this activity. You could choose to have them do it independently (lesson is narrated to help them along) or with you leading. This interactive activity will cover the following water quality parameters; pH, salinity, temperature and dissolved oxygen.

Nearpod Water Quality Lesson (without student interaction)

Nearpod Water Quality Lesson (with student interaction) - directions

1. Create a free nearpod account (https://nearpod.com/)
2. Ask Aquarium to send you the Water Quality nearpod link (email education@scaquarium.org)

3. After you receive Aquarium link, add lesson to your nearpod activities by clicking "Add to My Library"
4. Send to students using Live Participation
5. You'll be able to see their answers and interactions

Follow-up Questions

- Is pH affected by temperature or the salinity of the water? If so, explain your answer.
- How does temperature affect dissolved oxygen?
- Using the data collected on the local body of water, describe factors that may affect the parameters you tested.

Assessment

Students should write a report of their inquiry experiment (Part 2). The report should include the following: hypothesis, materials used, description of experiment, recorded data and observations, and a written conclusion describing whether their experiment supported their hypothesis or not.

Scoring rubric out of 100 points

Hypothesis written:	**20 points**
Materials listed:	**20 points**
Experiment described:	**20 points**
Data recorded and observations collected:	**20 points**
Conclusion written with hypothesis discussed:	**20 points**

Cross Curricular Extensions

STEM Extension
Ask students to develop techniques/processes to make "dirty" water clean again. First they would need to research their local water filtration system. Then provide them with a sample of "dirty" water (sand, coffee grounds, garlic powder,…). Have various materials available (fine wire mesh, coffee filter, panty hose, hot plate for heating, funnel, tubing,…) to select for testing their technique/process. Have them save a small sample for the before and after comparisons and have them present their water filtration process to the class. A spectrophotometer could be used to more precise comparisons. There could be a competition between teams to determine which technique worked best.

Social Studies Extension
Students will research the quality of water in their local watershed. They will design a conservation campaign to help clean polluted areas and preserve those areas designed as healthy streams/rivers.

Math Extension
Students will calculate the current speed of a local stream or river at different times throughout the year. They will graph the information and compare the data and discuss the factors that may affect the flow rate.

Language Arts Extension
Students will develop "water quality" pen pals with other students throughout the state. They can share their data collected in this way and discuss the factors that influence the local stream/body of water. They can share ideas for creating a conservation message to be shared with others.

Resources

Teacher Reference Books

Kovacik, Charles F. and John J. Winberry. South Carolina: the Making of a Landscape, University of South Carolina Press, Columbia, 1989.
This wonderful reference book provides information on the abiotic factors that determine the habitats of South Carolina.

Murphy, Carolyn Hanna. Carolina Rocks!: The Geology of South Carolina, Sandlapper Publishing Co., Inc., Orangeburg, 1995.
Information on the geology, topography and formation of all of the regions in South Carolina.

Plummer, Charles C. and David McGeary. Physical Geology, Wm. C. Brown Publishers, Iowa, 1991.
Though admittedly college textbooks are often a little too dry and in-depth, with their text, photographs and illustrations they are often the best resources for finding information on a particular subject. This college textbook is an excellent resource for anyone wanting to know more about geology.

Teacher Reference Websites

Chesapeake Bay Foundation Environmental Education
www.cbf.org/
The Chesapeake Bay Foundation has put together an exemplary watershed protection program that encompasses many states. This site includes information on what they have done in this program as well as curricula and other education related items.

EPA'S Environmental Education Center
www.epa.gov/teachers/
Provides information on water and watersheds and links to other sites.

EPA Office of Water: Office of Wetlands, Oceans and Watersheds
www.epa.gov/owow/
Provides information on watersheds, wetlands, water quality plus much more.

South Carolina Department of Health and Environmental Control (DHEC): Bureau of Water
www.scdhec.net/water
This site offers information on drinking water, water pollution control, watersheds plus much more.

Southern Appalachian Watershed Conservation Clearinghouse
http://sunsite.utk.edu/samab/proj/watershed.html
This site offers links to a number of websites related to watershed conservation in the Southeastern United States.

Surf Your Watershed: A Service to Help You Locate, Use, and Share Environmental Information about your Place
www.epa.gov/surf
This site allows you to learn specific information related to the watershed your town is located in.

U.S. Geological Survey
www.usgs.gov/
This site offers valuable earth science information on a variety of topics.

Water Science for Schools
http://ga.water.usgs.gov/edu/
Background information on water and watersheds is provided on this site.

Student Reference Books

Cone, Molly. Come Back, Salmon, Sierra Club Books for Children, San Francisco, 1992.
Learn how the students of Jackson Elementary School in Everett, Washington, cleaned a nearby stream, stocked it with salmon and protected it from pollution.

Student Fiction Books

Cherry, Lynne. A River Ran Wild, Gulliver Books/HBJ, San Diego, California, 1992.
Follow the environmental history of the Nashua River, from its discovery to present day. Learn how it was polluted during the Industrial Revolution but has since been cleaned.

Curricula

Aquatic Project WILD
Aquatic Project WILD is an interdisciplinary curriculum for K-12 teachers on aquatic wildlife and ecosystems. The activities cover a broad range of environmental and conservation topics.
For more information click on http://www.projectwild.org/ProjectWILDK-12AquaticcurriculumandActivityGuide.htm

JASON Science: Education through Exploration
The JASON Science is an interdisciplinary curriculum for K-12 teachers focusing on the geology, climate, biology and biodiversity of specific regions in the world. The activities cover a broad range of topics.
For more information click on: http://www.jason.org/public/whatis/start.aspx

Project WILD
Project WILD is an interdisciplinary curriculum for K-12 teachers on a broad range of environmental and conservation topics.
For more information click on: http://www.projectwild.org/

Project WET
Project WET is an interdisciplinary curriculum for K-12 teachers on water. The activities cover a wide range of water-related topics.
For more information visit the website at http://www.projectwet.org/