

Is It Healthy or In Trouble? Lesson Plan

Students investigate the causes of pollution in our surface waters.

Lesson Summary: This lesson will provide students with an opportunity to use interactive technology to explore real-life problems that are associated with the lakes in their community.

Grade Level: 6-8.

Time Allotted: Approximately 3 class periods (50 minutes each period).

Performance Objectives

References are to the Next Generation Sunshine State Standards (2007).

Science

- SC.6.N.1.1 Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
- SC.7.E.6.6 Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.
- SC.8.N.1.2 Design and conduct a study using repeated trials and replication.
- SC.8.N.1.3 Use phrases such as "results support" or "fail to support" in science, understanding that science does not offer conclusive 'proof' of knowledge claim.
- SC.8.N.1.4 Explain how hypotheses are valuable if they lead to further investigations, even if they turn out not to be supported by the data.
- SC.8.N.1.5 Analyze the methods used to develop a scientific explanation as seen in different fields of science.
- SC.8.N.1.6 Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence.
- SC.8.N.3.1 Select models useful in relating the results of their own investigations.

Language Arts

- LA.6.4.2.2 The student will record information (e.g., observations, notes, lists, charts, legends) related to a topic, including visual aids to organize and record information and include a list of sources used.
- LA.6.6.2.3 The student will write an informational report that includes a focused topic, appropriate facts and relevant details, a logical sequence, a concluding statement, and list of sources used.

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- LA.8.6.2.1 The student will select a topic and develop a search plan with multiple research strategies, and apply evaluative criteria (e.g., scope and depth of content, authority, reputation of author/publisher, objectivity, freedom from bias) to assess appropriateness of resources;

Prior Knowledge

Students should have prior knowledge of what is science in addition to the steps in a scientific investigation. Teachers should review with students the procedures of scientific methodology. To activate prior knowledge teacher should ask students to respond to the questions below:

1. What is science?
2. What procedures are at the core of scientific methodology?

Teachers should allow students to share their response with the class and then use students' responses to engage students in a class discussion of what is-and what is not science. Teacher should then engage students in a discussion of the different steps that are involved in a scientific investigation. Teacher should help students formulate hypotheses and researchable questions.

Students should have prior knowledge of some of the physical, chemical and biological problems that are associated with some of the lakes in their communities. Teachers can review with students the ["Learn More" about Impaired Waters](#) on the [Orange County Water Atlas](#).

Topic Overview: Our surface water is a valuable natural resource. Unfortunately, as Florida's population has grown and urban and agricultural development have increased, its surface waters have become increasingly polluted.

One of the most troublesome types of pollution is from substances such as nitrates and phosphates. An excess amount of these nutrients in our surface waters overstimulates the growth of aquatic plants and algae. As these plants die and decompose, the decay process depletes the oxygen available in the waterbody. This, in turn, proves very harmful to aquatic organisms as it affects the respiration ability of fish and other invertebrates that reside in water.

There are other causes of pollution. For example, silt and other suspended solids from places such as construction sites and urban areas are swept into surface water bodies when it rains. Under natural conditions, lakes, rivers, and other water bodies undergo eutrophication, an aging process that slowly fills in the water body with sediment and organic matter. When these sediments enter various bodies of water, fish respiration becomes impaired, plant productivity and water depth become reduced, and aquatic organisms and their environments become suffocated.

Water managers who work to improve the quality of our lakes throughout Orange County collect water samples regularly and measure the water's chemical properties to assess each lake's physical, chemical, and biological status on an ongoing basis. In this investigation, students will explore real life

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problems that are associated with the lakes of their community. Students will be able to use the interactive technology from Orange County Water Atlas to enhance their scientific inquiry abilities.

Key Vocabulary

Agricultural pollution

the liquid and solid wastes from farming, including stormwater runoff, leaching of pesticides and fertilizers into groundwater, erosion, dust from plowing, animal manure and carcasses, and crop residues.

Coliform bacteria

Bacteria found in the intestinal tracts or feces of humans and other warm-blooded animals (also called fecal coliform). Their presence in water indicates fecal pollution and potentially dangerous bacterial contamination by disease-causing organisms such as streptococcus

Dissolved oxygen (DO)

The oxygen freely available in water that is vital to the existence of fish and other aquatic life. It is considered the single most important indicator of a water body's ability to support desirable aquatic life. Secondary and advanced waste treatment systems are usually designed to protect DO in waste-receiving waters.

Phosphorus

An essential chemical food element that can contribute to the eutrophication of lakes and other water bodies by fostering the growth of plant life. Phosphorus pollution is primarily caused by urban or agricultural stormwater runoff containing fertilizers, or by runoff that contains animal manure.

Surface waters

All bodies of water on the Earth's surface that are naturally open to the atmosphere (such as rivers, lakes, reservoirs, streams, impoundments, seas, coastal and freshwater wetlands, lagoons, and estuaries) and all springs, wells, or other collectors that are directly influenced by surface waters. Because water vapor evaporates from surface waters into the air, surface waters play an essential role in the hydrologic cycle through which all water on the Earth moves.

Materials

- Classroom water testing kit for nitrogen and phosphorus
- Computer with internet access
- Containers for water samples
- Digital camera (optional)
- Microscope
- Secchi disk (purchased, or see references for how to make one)

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References

The following documents are available in the Orange County Water Atlas Digital Library.

[Final Water Quality Standards for the State of Florida's Lakes and Flowing Waters](#) (Factsheet). 2010.
Office of Water, U. S. Environmental Protection Agency.

[How to Make a Secchi Disk](#)

Source: [New Hampshire Department of Environmental Services](#).

Other References:

Harrison, John Arthur. 2003. [The Nitrogen Cycle: Of Microbes and Men](#). Visionlearning Vol. EAS-2 (4), 2003.

Jazlin Ebenezer, Osman Nafiz Kaya, Devairakkam Luke Ebenezer. 2011. *Engaging Students in Environmental Research Projects: Perceptions of Fluency with Innovative Technologies and Levels of Scientific Inquiry Abilities*. Journal of Research in Science Teaching, Vol. 48, No. 1, pp. 94–116.

Mylavarapu, Rao. 2008. [Impact of Phosphorus on Water Quality](#). Institute of Food and Agriculture Science, University of Florida.

[Nutrients in the Nation's Waters: Too Much of a Good Thing?](#) 2009. United States Geological Survey Circular 1136.

[Total Phosphorus](#). Center for Aquatic and Invasive Plants, University of Florida

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Procedure

Engage/Elicit

Lead students in a discussion about water quality, asking them the following questions and recording their answers on the board for everyone to see:

- What do we mean when we say that water is "clean"?
- How do we know when water is "clean enough"? (Clean enough for what?, you might ask, and prompt them to think about different uses of water: drinking, bathing, swimming, fishing, wildlife use, recreation, industrial use, etc.)
- What are some ways we might measure the quality of water?
- What kinds of human activities affect the quality of water?
- How do natural processes affect water quality? (Rain, heat, wind, etc.)

Explore

1. Choose a lake near your school for students to visit and analyze. Be sure to choose a lake that has water quality data on the Orange County Water Atlas.
2. Visit the lake with students and have them take notes about its physical appearance (abundance of plants in and around the lake, general surroundings, presence/absence of litter, presence/absence of wildlife, clarity of water, etc.). You may wish to use a digital camera to take pictures of what you see.
3. Have students make these measurements of water quality at the lake:
 - a. Use a Secchi disk to measure water clarity.
 - b. Take water samples and examine the water's color and notice if it has any odor.
 - c. Look at the water under a microscope. Are algae or microorganisms visible?
 - d. Analyze the nutrients in the water using a test kit (see student handout).
4. Use the [Advanced Mapping Tool](#) on the [Orange County Water Atlas](#) to look at the land use around the lake. How might land uses of adjacent property be affecting its water quality? (Land use information is one of the map themes available using the tool.)
5. Ask students whether they think the lake is healthy, based on their observations.

Explain

Put students in groups of 3 or 4 and ask each group to come up with one question which they would like to have answered about the health of "their" lake. Explain to students that they will be conducting a scientific investigation on their questions.

Ask each group to make their question a "testable" problem statement. Have students discuss their testable problem statements with the teacher for feedback and approval.

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Have each group predict at least two possible outcomes/explanations for their selected problem statement.

Ask each student to make a list of ways to find out the answer to their question—to test which of their predictions is valid.

Teacher should then guide student groups in:

- Designing and conducting scientific investigation related to the hypothesis
- Collecting and analyzing the data
- Making logical connection between evidence and scientific explanation
- Using of tables, charts, and graphs to analyze and display data
- Communicating their findings, including defending scientific arguments connected with their investigation

Extend

Students should discuss the following questions;

1. Climate change is expected to produce extremely variable patterns of temperature and rainfall. How might prolonged higher temperatures impact the physical appearance of the lake studied?
2. How might unusually heavy rainfall affect the physical appearance of the lake?
3. How might unusually heavy rainfall impact the chemical and biological aspects of the lake?
4. How might more frequent violent storms impact the different habitats surrounding the lake?
5. How might an extended period of drought impact the physical, chemical and biological aspects of the lake?

Exchange/Evaluate

Students should present their research findings for feedback and suggestions from the teacher as well as their peers. Teacher may also choose to invite guests (i.e., other teachers, administrators, or members from the community) to provide feedback to students.

Teacher should also collect students' written research projects and evaluate students' understanding based on the criteria below:

Scientific Inquiry Abilities	Missing (0 points)	Beginning (1 point)	Developing (2 points)	Proficient (3 points)	Point Total
1. Define scientific problem based on personal or societal relevance with need and/or source	Defines no scientific problem with need and/or source	Defines scientific problem improperly; without defensible statement of need and/or source	Defines scientific problem partially accurate with either defensible statement of need or source	Defines scientific problem accurate with defensible statement of need and source	

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2. Formulate a statement of purpose and/ or scientific question	Formulates no statement of purpose and/ or scientific question	Formulates statement of purpose and/or scientific question with no clarity	Formulates statement of purpose and/or scientific question with partial clarity	Formulates statement of purpose and/or scientific question with clarity	
3. Formulate a testable hypothesis and propose explanation	Formulates no testable hypothesis and proposes no explanation(s)	Formulates testable hypothesis and proposes incoherent explanation	Formulates testable hypothesis and proposes partially coherent explanation(s)	Formulates a testable hypothesis and proposes coherent explanations	
4. Design and conduct scientific investigation related to the hypothesis	Demonstrates no logical connections between scientific concepts guiding a hypothesis and research design	Designs and conducts scientific investigation related to the hypothesis; methods and procedures are outlined but difficult to follow	Designs and conducts scientific investigation related to the hypothesis; methods and procedures are outlined but not logically sequenced	Designs and conducts scientific investigation related to the hypothesis; methods are logically sequenced and outlined	
5. Analyze data systemically	Analyzes no data	Analyzes data with errors and/or gaps	Analyzes data with minor inaccuracies	Analyzes data with accuracy	
6. Make logical connection between evidence and explanation	Makes no logical connection between evidence and explanation	Makes weak logical connection between evidence and explanation	Makes fair logical connection between evidence and explanation	Makes good logical connection between evidence and explanation	
7. Defend scientific arguments connected with investigation, evidence, and scientific explanation	Defends no scientific arguments connected with investigation, evidence, and scientific explanation	Defends scientific arguments weakly connected with investigation, evidence, and scientific explanation	Defends scientific arguments reasonably connected with investigation, evidence, and scientific explanation	Defends scientific arguments strongly connected with investigation, evidence, and scientific explanation	

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