

[Header] PBIS Learning Set 2
Section 2.5 INTRODUCTION

2.5 Read
More Water-Quality Indicators

1 class period* ►

Overview

Students have looked at three water quality indicators: phosphate and nitrate levels, pH, and dissolved oxygen. Students learned that temperature and turbulence can affect levels of dissolved oxygen in a body of water. In this section, students learn more about the influence of temperature. They read about the effects of thermal pollution on photosynthesis in water plants and learn that excessive growth of these plants can diminish dissolved oxygen. Students learn that turbidity is a measure of water clarity and that fecal coliform bacteria in a body of water is an indicator of poor water quality. This information adds to science knowledge that students can use when they diagnose possible water quality problems that might be faced by the town of Wamego if its community and its ecology are changed.

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
Water quality depends on a variety of indicators including temperature, turbidity, and fecal coliform bacteria levels.	When asked for indicators of water quality, students should be able to identify temperature, turbidity, and fecal coliform bacteria as some of the factors that affect water quality.
Thermal pollution, the result of human activity, causes water temperatures to increase, reduces water quality, and harms the ecosystem.	Students should be able to say that thermal pollution, the rise in water temperature, harms the ecosystem because it decreases available oxygen and there fore harms aquatic organisms.
Turbidity is a measure of how opaque water is and may increase due to disturbances in land structure or in the river bed as a result of human activity.	Students should be able to relate that turbidity increases because of changes in land use and in rivers.
Fecal coliform bacteria, normally found in animal digestive tracts, can cause disease for humans and other animals when the bacteria enter a watershed in contaminated runoff or untreated sewage.	Students should be able to say that the presence of fecal coliform bacteria in a water source indicates poor quality water.

*A class period is considered to be one 40 to 50 minute class.

Homework Options

Reflection

- **Science Process:** How would a scientist out in the field measure the turbidity of a body of water? *(The scientist would lower a Secchi disk into the water and then raise it. A reading would be taken at the point where the disk disappears from view as it is lowered and reappears as it is raised in the water.)*
- **Science Content:** Why do scientists have to think about dissolved oxygen as well as thermal pollution when fish, such as trout, begin to die in a stream? *(Answers will vary, but students should include that some organisms, such as trout, survive in a narrow temperature range. If the water temperature rises, the fish cannot survive because the increased temperature lessens the amount of dissolved oxygen.)*

Preparation

- **Science Content:** You and your group are scientists preparing to do some tests in the field. You want to test for changes in temperature in the local river. You are not certain where this is happening. Is it near the big bakery? Is it further down stream near the factory that manufactures cars? Explain how your group would test for temperature differences in the river. *(Answers will vary but students' answers should include that temperatures should first be checked further up the river as close to its source as possible, then again near the factories in question.)*
- **Science Content:** Your group makes up the committee in Wamego that is preparing for the annual trout festival. Some people on the committee want to allow motor boats on the river this year during the festival and some want to ban the use of motor boats. What water quality indicator might be more common if motor boats were allowed? How might this affect the trout and the festival? *(Answers will vary but turbidity would probably increase if motor boats are allowed. This could lead to an increase in the water temperature (thermal pollution) as particles in turbid water absorb more heat from sunlight. This might reduce the number of trout available because it would change the temperature range in which they normally live.)*

[header] 2.5 Read

SECTION 2.5 IMPLEMENTATION

2.5 Read

More Water-Quality Indicators

*1 class period**

In this section, students complete their introduction to major water quality indicators that are used to test water throughout a watershed.

[icon] Guide

Have students read the opening paragraph to refresh their knowledge of the water quality indicators they have already studied and to introduce them to three additional indicators: thermal pollution, turbidity, and fecal coliform bacteria.

Temperature

10 min.

Students begin to appreciate the complexity of the ways in which temperature can affect an ecosystem.

META NOTES

It has been found that trout feed best when the temperature of the water is rising into their optimum feeding range (10°C to 20°C) rather than when it is falling into this range from a higher temperature.

[icon] Engage

Ask a student to summarize what the class has already learned about temperature and its effect on water quality.

Explain that sometimes when an industry is built near a river, it is because the factory needs water to cool down part in the manufacturing process. The water is drawn from the river and later returned to the river. But the temperature of the returning water is higher. This can have an effect on the plants and animal life in the river and change the quality of the river water. Refer students' attention to the table on p. 76 in the student text that shows original temperatures and the temperature of changed water (in parentheses).

TEACHER TALK

“In the table named Water Quality and Temperature, the first temperature is the temperature of the original water source, such as a river or a pond. The temperature in parentheses is the temperature of the water after it has been used and returned to the river or pond. What do you notice about these temperature differences? (As the difference between the original water temperature and the temperature of the returning water becomes greater, the quality of the water becomes less.) Scientists may use these differences as an indicator of water quality.”

[icon] Guide and Assess

Explain the range of water temperature that trout can live in water that ranges from 2°C to 23°C and they feed best between 10°C and 20°C. List this feeding temperature range and also list the temperature information about carp from the caption on p. 81 in the student text. Ask the class to compare the temperature ranges and discuss the dissolved oxygen levels they might find at these two temperature ranges. Have students discuss whether trout and carp would be found living in the same stream. Listen for students to begin to make a connection between stream temperatures and what might happen if the temperature of the Crystal River in Wamego were to rise.

TEACHER TALK

“Think about what you know about how temperature and dissolved oxygen are related. Which fish, the trout or the carp, probably lives in a stream with higher dissolved oxygen? If a factory along a river caused the temperature of the water to rise, which fish would most fishers be catching in the river? If the temperature of the Crystal River rises, will the town of Wamego have to change the name of its festival? Why or why not?”

Turbidity

10 min.

Students should be becoming aware that water quality is not merely a question of whether water is safe to drink, but also whether it is good of high enough quality to support plant and animal life in and around it.

[icon] Engage

Turbidity is a term that students may not be familiar with. Query them as to what they think the word *turbidity* means and list their ideas.

To enable students to get an idea of what turbidity is, you might demonstrate with a jar of water with some soil. Initially show the jar after its contents have been standing for an hour or more. Mud will be settled at the bottom and the liquid should be fairly clear. Then stir the contents of the jar. The contents should cloud up or become turbid with particles of soil. Soon the particles will begin to settle out.

[icon] Guide

Explain that various types of materials make water turbid or difficult to see through. Much of the particulate matter is made up of fine particles of soil. If the water becomes turbulent, then the fine particles can cloud the water.

Encourage students who might want to make a model Secchi disk to test various levels of turbidity. This can be made of simple materials on a small scale with water of various clarities in the classroom.

META NOTES

Bacteria, viruses, and other pathogens can be harder to detect in turbid water. Turbid waters can absorb and retain more heat and contribute to the growth of pathogens in a contaminated water source.

Fecal Coliform Bacteria

10 min.

META NOTES

According to the Centers for Disease Control and Prevention Agency, the presence of coliform bacteria in a water source indicates a breakdown in the water treatment process so that human or animal wastes have leaked into the system.

META NOTES

Chlorine is an important part of making water safe to use. Chlorine has been linked with some forms of cancer but, throughout the world, it still is the main factor between having safe, clean drinking water and having contaminated, non-potable water.

[icon] Guide

Inform students that water is treated before it enters their homes and after it leaves their homes. Water that has been treated and enters their homes is safe to drink and is called *potable* water. Some of this water is pumped from aquifers, reservoirs, lakes, or wells. Water that leaves their homes is made up of all the water from kitchens, bathrooms, dishwashers and washing machines and is called *wastewater*. Water quality in the United States is protected by the Safe Drinking Water Act, amended in 1996. This act is made up of rules that regulate the nation's drinking water supplies. Tell students how water is treated in most towns and cities.

TEACHER TALK

“Wastewater from homes, schools, hospitals, and businesses is collected in sanitary sewers and carried to sewage treatment plants. At a sewage treatment plant, water goes through a series of screens or filters that remove debris. Then it is mixed with microorganisms (bacteria) that feed on the very small materials that might still be in it. Eventually this mixture has oxygen stirred into it. The oxygen causes the microorganisms to expand and sink to the bottom where they can be removed.

The water is then disinfected with chlorine. This means that any remaining harmful pathogens are killed. Chlorine is very strong so other chemicals are added to neutralize the chlorine. Finally, some of the treated wastewater is released into streams and in some cases, an ocean. Some of this water is sprayed onto large grassy areas such as golf courses. Some is stored.

Sewers are part of the *infrastructure* of a city. When more businesses are built, more homes, schools, and shopping facilities are also built and infrastructures have to also be expanded.”

Explain that much of the water that people can drink is pumped from ground water sources such as aquifers and surface water resources, such as rivers, lakes, and streams. A smaller percentage of people have their own wells. Water is treated before it is allowed into homes to be consumed.

With the above information in mind, ask students why it would be important for Wamego to be able to treat increased waste materials if the new FabCo factory is built. List their ideas.

META NOTES

The Safe Drinking Water Act of 1996 lists maximum allowable levels of nearly 100 contaminants that can exist in drinking water.

Stop and Think

20 min.

During the class discussion, students should be encouraged to ask each other questions that assist in refining and articulating their answers.

[icon] Get Going

Let students spend ten minutes answering the questions on their own. Then transition them to a class discussion. If, during the class discussion, students disagree, ask students with opposing viewpoints to defend their stands. Most student responses should contain at least the following:

1. As temperature increases, dissolved oxygen decreases.
2. Aquatic plants release oxygen into the water through photosynthesis. This increases the level of dissolved oxygen. However, increased plant growth means that more plants are available to decay in the water. Bacteria that decompose dead vegetation use the dissolved oxygen during this process.
3. Changes in temperature change the level of dissolved oxygen in the water. The affects what can stay survive in the water or not survive.
4. Thermal pollution occurs when the temperature of the water rises, often because of human activity.
5. Scientists measure temperature in rivers, lakes, or streams at the source and again at another point further down the river, lake, or stream. If the temperature difference is greater than 10°C, the water quality is poor; if the temperature difference is small (0 to 2°C), water quality is classified as excellent.
6. The more particles in water, the more sunlight it absorbs. This increases the temperature of the water and decreases the levels of dissolved oxygen.
7. Turbid water is caused by soil erosion, urban runoff, and disturbances in the sediments in the bottom of the river.
8. When fecal coliform is measurable in a stream, it means that there is a greater chance that pathogens are present in numbers to cause health problems.
9. Fecal coliform bacteria end up in a river when untreated sewage is dumped or leaks into the river.
10. One way humans affect water quality is through changes in land use or increases in systems that stress an existing system.

[icon] Evaluate

Listen for students' understanding of how these important indicators of water quality can affect their health and the health of the environment in which they live.

Targeted Concepts,	How do I know if students got it?
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Skills, and Nature of Science	
Water quality depends on a variety of indicators including temperature, turbidity, and fecal coliform bacteria levels.	<p>ASK: Select one of these three indicators and write a paragraph that explains how a scientist might use the indicator to check on water quality.</p> <p>LISTEN: Answers will vary based on the selected indicator but should include the following. For temperature, thermal pollution is checked in a stream by comparing the measured temperature of the water at its source and again at a second point along the stream. For turbidity, a scientist might use a Secchi disk to check the clarity of the water in the same place on two different days. For fecal coliform, a scientist would check for the presence of the bacteria at places where water enters a stream.</p>
Thermal pollution, the result of human activity, causes water temperatures to increase, reduces water quality, and harms the ecosystem.	<p>ASK: During a very hot, bright summer, you notice an unpleasant scum and smell coming from the lake in the town park. What is one explanation for these changes?</p> <p>LISTEN: Answers will vary but you should hear students say that increased temperatures caused any plants in the lake to grow rapidly and eventually die off. Bacteria in the water decomposed the dead plants and used up dissolved oxygen.</p>
Turbidity is a measure of how opaque water is and may increase due to disturbances in land structure or in the river bed as a result of human activity.	<p>ASK: Land has been cleared of trees and plants for a development of new homes. Shortly after there is a heavy rainstorm. The local stream, which is normally clear, becomes muddy with sediment. Describe the turbidity of the stream and give one explanation for the change in the stream's turbidity?</p> <p>LISTEN: Answers will vary but students should be saying that the stream is muddy because the land has been cleared of vegetation and a lot of soil carried away in runoff because there are no plants to hold the soil in place.</p>
Fecal coliform bacteria, normally found in animal digestive tracts, can cause disease for humans and other animals when the bacteria enter a watershed in contaminated runoff or untreated sewage.	<p>ASK: There is a break in a sewer line in your town and people are told to boil any water used for drinking, cooking, and brushing teeth. Why are they told to do this?</p> <p>LISTEN: Answers will vary but students should be able to say that these precautions are being taken to prevent people from consuming water that may be contaminated with fecal coliform.</p>

Teacher Reflection Questions

- In this section, students learned about contaminants in water. Do they understand that in real life, all drinking water contains a number of contaminants at allowable levels.
- Were students able to make a connection between the water quality indicators they learned about and the information they learned about in the watershed discussion in *Learning Set 1*?
- Did most students participate in class discussions? How can this be further encouraged?