From the Mountains to the Estuary: From the Schoolyard to the Bay

Meaningful Watershed Experiences for Grade 6 Students

Created by:

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Field Experience

Water Quality Testing

How's the Water?

Overview

Students will use chemical tests to determine the water quality of a local pond.

Teacher Background: Water Quality

- In 1972 the Clean Water Act was passed to help protect our waters.
- About 1,500 miles of Virginia's waterways don't meet state water quality standards.
- The biggest water quality problem for the Chesapeake Bay is nutrient over-enrichment caused by run off from fertilizers, agriculture, and animal waste.
- Excess nutrient levels (in particular nitrogen and phosphorus) lead to increased growth of algae ("blooms"). As the algae die, bacteria consume oxygen as they decompose the algae.
- Anoxia and Hypoxia are severe in some portions of the bay waters

  hypoxia- water with less then 1 mg/L of dissolved oxygen

  anoxia- water with no oxygen

- There are two major categories of types of pollutants:

  point sources- can be identified to a particular source e.g. Sewage plant

  non-point- nutrients are carried by surface water run-off- discharge from farms, residential lots, developments, parking lots and even forests

- The main focus of improving water quality in Virginia is through agricultural conservation practices, improvements in water treatment plants, and decreased use of fertilizer for residential lawns.
- There are two types of water quality criteria, one is designed to protect aquatic life the other to protect people from drinking polluted water or consuming fish or shellfish from polluted bodies of water
- Water contaminants are measured in parts per million (ppm), parts per billion (ppb) and even parts per trillion (ppt).
- People can smell petroleum products as low as 10 parts per billion- that is equal to one drop of water in an Olympic size swimming pool.
- Because predators can consume large amounts of prey, the contaminant can accumulate in the top predators who might suffer ill results. This is called *bioaccumulation*. Example: a minnow absorbs a 10 ppb contaminant, then a bass eats 10 minnows (10 x 10 = 100 ppb), then a human eats 10 bass (10 x 100 = 1000 ppb).

Materials

- Water quality test kits (includes dissolved oxygen, nitrate, pH, phosphate, turbidity)
- Thermometers w/strings
- Small white buckets
- Timers for Dissolved oxygen, nitrate, phosphate
- Clipboard with water quality data sheet
- Pencil

Setting the Stage

Explain to the students that indicators such as the presence of macro invertebrates and water chemistry can be used to assess the quality of a body of water. Tell them that they will be going to test the water to determine if the water chemistry falls into acceptable parameters. Identify the parameters that students will be measuring—pH, temperature, dissolved oxygen, nitrogen, phosphorus, and turbidity.

Acquisition of Learning

1. Have students broadly survey the area surrounding the water.

   Question: How do you think the surrounding land area affects the quality of the water?

2. Introduce the area by discussing the topography of the land.

   Question: How would the rain that falls on the surrounding area, such as in the parking lot area, affect the pond?

3. Where does water flow from here? *(to Potomac River, Chesapeake Bay, Atlantic Ocean)*

4. Guide students to the edge of the water.

   Question: What is your estimate of the percentage of bare soil you observe*? (Students should circle the amount of bare soil on the data sheet.)*

5. Head down to water and have students sit in five groups of 3-5 students in each group.

6. Explain that they are going to use the scientific method to test the water quality. What is the first step of the scientific method? *(Ask a Question)*

7. If we want to study water quality what would be a good question to ask? *Is the water clean? Is the water polluted? Is the water quality good? Are all possible answers*

8. After asking a question what is the next step? *Create a hypothesis or make a prediction*- do you think the water is clean dirty or somewhere in-between? *Allow some time for answers*

9. What is the next step in the scientific method? *Test hypothesis- do the experiment and collect data*

10. What do we need of we are testing water quality? *Water!* Give each pair of students a container for water. Have 1 student from each group collect ½ a container of water.

11. Ask students to observe the water in their containers. What do we need to record next on the data sheet? *Appearance*- have them record their answer e.g. green (algae); brown (sediments); orange or blue (copper from pesticides); oil sheen; no unusual color.

12. What's next? *Smell* Demonstrate the correct procedure for smelling the water-*wafting* Have students record any odor (sulfur, musky, chlorine, none) on their data sheets.

13. Have every student place finger in the container to test the water temperature. Question: What is your estimate of the water's temperature? Is this an accurate way to measure temp? *No* What do we need? *thermometer*

14. Hand out one thermometer to every pair of students. Have students use thermometers to measure the air temperature. Record the data on the sheet. Then have the students measure the water temp. Students should record the water temperature on their data sheet. While they are waiting for the water temperature, review where water flows from there. The watershed address. E.g. Young's Branch creek to Bull Run river to Occoquan river to Potomac river to Chesapeake bay

15. Show students one of the kits. Explain that each kit will measure a different water quality indicator. Show the students the components of each kit including test tubes, test tabs, timer, and card with results and instructions.

16. Hand out one kit per group and the water quality "expert cards". Instruct students to read instructions and allow students to conduct test. Assist as needed.

17. When each test is complete, the student groups should communicate their results to entire group and they should record the results. They should report to the other students from the water expert card. Assess student understanding of test when they report using the information below.


secchi disk

18. Test for turbidity. What does turbidity measure? (*turbidity is caused by suspended particles*) Short-term turbidity can be caused by natural runoff, wave action, or turbulent water. High levels of turbidity can be caused by runoff from construction sites, urban areas, and agricultural fields. Question: Why do you think high turbidity over long periods of time can decrease productivity of ecosystem? (sediments *may clog the gills of fish and invertebrates decrease photosynthesis)*

- Student group should show the turbidity tube, report the results, and demonstrate how the Secchi disk works.

19. Determine the pH of the water. What does pH measure? (*pH measures if a solution is an acid or a base; pH refers to "Power of the Hydrogen"—a measure of Hydrogen Ion (H+) concentration in solution. Acids have more H+; bases have higher concentration of Hydroxyl ions (OH-)*

- Show students a pH chart. Questions: What is the range of the scale? What numbers indicate a base? An acid? *(pH scale ranges from 0-14, below 7 is acidic, above 7 is basic, 7 is neutral the scale is logarithmic so each increase is ten times greater or lesser than previous increment)* Ask students to name substances they think are acidic (lemons) and basic (ammonia).
- Have students make predictions about the pH of the water then record the actual results.

20. Test for dissolved oxygen. What do fish and aquatic invertebrates breathe? *(oxygen)* What is the chemical formula for oxygen? *(O_2)* Explain that the ability of water to support life is strictly limited by the amount of dissolved oxygen. Oxygen enters the water through the process of photosynthesis and direct diffusion from the air by wind and wave action.

- Question: What factors affect the amount of oxygen that water can hold? *(temperature, salinity, the amount of suspended and dissolved particles)*
- The amount of oxygen in water ranges from 0 to about 15 parts per million. Most freshwater organisms require at least 4 ppm dissolved oxygen.
- Have students report and record results.

21. Test for nitrogen. What chemical cycles have you learning about in science? *(water, oxygen/carbon dioxide)* Review nitrogen cycle. Explain that the element nitrogen exists in several forms and is constantly changing its state in the nitrogen cycle. The nitrogen cycle is complex and a key component of food and energy cycles within living organisms. Under normal circumstances nitrogen is effectively cycled in the environment. Pollution from fertilizers, sewage, animal waste and even air contaminants produce excess nitrogen which may be toxic to aquatic organisms. Unpolluted water usually has less then 1ppm of nitrate. Too much nitrogen will result in algae blooms.

- Have students report and record findings on their data sheets.

17. Test for phosphorus. Explain that an abundance of this element can also cause algae blooms, which in turn affects dissolved oxygen and plant and animal life. Unpolluted water usually has less then 0.03 ppm of phosphorous.

    - Students should report and record findings on their data sheets.

18. After "record data", what is the next step in the scientific process? *(analyze data)*

19. From your analysis, what do you conclude about the quality of water here? Check that students have correct quantities marked off. *(allow for discussion and have students make a conclusion)* Was your prediction correct?

21. From their results, have the students determine a letter grade to assign to the water. (it will usually be an A or B)

22. Ask the students to predict what grade the Chesapeake Bay received? Show them the Bay Report Card. Explain that all the factors they tested are problems for the Bay.

20. Have students clean up. Students should pour reacted samples into waste container, rinse test tubes in a bucket of water and return them to the box. Collect boxes and check to be sure that everything is in them. Direct students empty the remaining water in their buckets into pond. Waste bucket contents can be poured down the toilet after all groups have been seen.

Closure:

Based on your results, are there any suggestions for how to improve the water quality? Have each group of students come up with one way they can help they Bay. Does the water quality here affect the water quality in the Potomac River, Chesapeake Bay, and Atlantic Ocean?

Teacher Note:

When going over results make sure students understand the units of measurement (e.g., parts per million—explanation of 4ppm -if a million buckets on dock only 4 are filled with substance- some pollutants are measured in *parts per billion or even trillion*- very low concentrations can be a problem. Also explain the in standing water like a small pond; you would tend to find more organisms that can tolerate low DO because of the lack of wind and waves. In the Bay, most organisms, except bottom dwellers, require 5ppm or higher.

Student Data Sheet for Watershed Investigations

Name:_____ **Date:**_____

Water Quality

Bare Soil Around Water: (Circle One)

Excellent	Good	Fair	Poor
0 - 10 %	11 - 40 %	41 - 80 %	81 - 100 %

Water Appearance: Color_____

Clarity_____

Water Odor: _____ **Intensity** Circle if the water had an odor: **faint, distinct, strong**

Temperature (Degrees C**): Air**_____ **Water**_____

	Excellent	Good	Fair	Poor
Dissolved oxygen ppm	7-11	5-6	3-4	0-2
pH	7	6 or 8		4, 5, 9, 10, 11
Nitrate ppm	0	1-4	5	Higher
Phosphate ppm	0 - 1	2	4	Higher
Turbidity (JTU)	0	0 to 40	40 to 100	100

Conclusion: Based on your results, what grade would you give to this body of water? _____

How does this compare to the grade that the Chesapeake Bay received? If they are different, explain why?

Macroinvertebrates

1. How many different species did your group find? _____
2. Using the viewers, Brock scopes, and ID cards, identify the organisms your group found. Circle them on the table below.

Sensitive to Pollution:	Somewhat Sensitive to Pollution	Tolerant of Pollution
Mayfly Larvae	Scuds	Leeches
Stonefly Larvae	Clams	Midge larvae
Riffle beetle	Crayfish	Blackfly larvae
Water penny	Damselfly larvae	Aquatic worms
Hellgrammite	Dragonfly Larvae	Flat-coiled snail
Caddisfly larvae	Beetle larvae	Left-opening snail
Right-opening snail	Fishfly larvae	
	Alderfly larvae	
	Cranefly larvae	
	Sowbug	

3. Based on the organisms you found, what is your conclusion about the water quality?
   a. Good b. Poor c. Needs further study
4. List three factors that might influence the number and types of organisms you found:
   a. _____ b._____ c._____