Original source: NASA Explores
Modified by Robin Havens Gary
Environmental Science Institute, UTOPIA project

Is your water clean?

Subject: Science (Chemistry, Biology or Earth Science)
Grade level: 9-12

Rationale or purpose: Over 2 million people rely on groundwater from karst aquifers in central Texas. Due to the high porosity and permeability of karst landscapes, inputs such as rain, streams, and rivers influence groundwater quality. In this lab, students will be able to compare the water quality of rainwater, cave water, tap water, and river water. This lesson involves students testing samples of water from different sources for pollutants and discussing the possible sources of these pollutants.

Source of Lesson: http://www.nasaexplores.com/show_912_teacher_st.php?id=021220142457

Materials:

- Goggles (per student)
- Rubber gloves
- Phosphate test kit and directions
- Coliform test kit and directions
- pH paper
- Data Sheets (See the Student Data Sheet)
- NASA Explores "Water: It's not just for drinking" article (http://media.nasaexplores.com/lessons/02-054/9-12_article.pdf)
- Alcohol (for hand cleaning)
- Electronic Sensor (electrodes to test for current conduction through water)
- Microscopes
- Water samples rainwater, cave water, tap water, and river water (Natural Bridge Caverns has a water fountain that pulls water from the cave).
- Glass containers to hold water samples (four per group)

Length of Lesson: 50min

Objectives:

Chapter 112

Subchapter B

112.22-
1A- demonstrate safe practices during field and laboratory investigations
2B- collect data by observing and measuring
2C- analyze and interpret information to construct reasonable explanations from direct and indirect evidence
2D- communicate valid conclusions
4A- collect, analyze, and record information using tools
7B- classify substances by their physical and chemical properties

112.23-
1A- demonstrate safe practices during field and laboratory investigations
2B- collect data by observing and measuring
2C- organize, analyze, make inferences, and predict trends from direct and indirect evidence
2D- communicate valid conclusions
4A- collect, analyze, and record information to explain a phenomenon using tools

7C- recognize that compounds are composed of elements
112.22-
1A- demonstrate safe practices during field and laboratory investigations
2B- collect data by observing and measuring
2C- organize, analyze, evaluate, make inferences, and predict trends from direct and indirect evidence
2D- communicate valid conclusions
4A- collect, record, and analyze information using tools
12C- predict the results of modifying the Earth's nitrogen, water, and carbon cycles
14C- describe how human activities have modified soil, water, and air quality

Subchapter C
112.43-
1A- demonstrate safe practices during field and laboratory investigations
2B- collect data and make measurements with precision
2C- organize, analyze, evaluate, make inferences, and predict trends from data
2D- communicate valid conclusions
12C- compare variations, tolerances, and adaptations of plants and animals in different biomes
112.44-
1A- demonstrate safe practices during field and laboratory investigations
2B- collect data and make measurements with precision
2C- organize, analyze, evaluate, make inferences, and predict trends from data
2D- communicate valid conclusions
4C- evaluate the impact of human activity such as methods of pest control, hydroponics, organic gardening, or farming on ecosystems
4D- predict how the introduction, removal, or reintroduction of an organism may alter the food chain and affect existing populations
5F- evaluate the impact of human activity and technology on land fertility and aquatic viability
8A- analyze and describe the effects on environments of events such as fires, hurricanes, deforestation, mining, population growth, and municipal development
112.45-
1A- demonstrate safe practices during field and laboratory investigations
2B- collect data and make measurements with precision
2D- organize, analyze, evaluate, make inferences, and predict trends from data
2E- communicate valid conclusions
4A- differentiate between physical and chemical properties of matter
4B- analyze examples of solids, liquids, and gases to determine their compressibility, structure, motion of particles, shape, and volume
12C- evaluate the significance of water as a solvent in living organisms and in the environment
112.46-
1A- demonstrate safe practices during field and laboratory investigations
2B- collect data and make measurements with precision
2D- organize, analyze, evaluate, make inferences, and predict trends from data
2E- communicate valid conclusions
4B- research and identify biological, chemical, geological, and physical components of an aquatic ecosystem
4C- collect and analyze baseline quantitative data such as pH, salinity, temperature, mineral content, nitrogen compounds, and turbidity from an aquatic environment
6A- identify the role of various cycles such as carbon, nitrogen, water, and nutrients in an aquatic environment
8B- analyze the cumulative impact of natural and human influence on an aquatic system
8D- analyze and discuss human influences on an aquatic environment including fishing, transportation, and recreation
10C- identify water quantity and quality in a local watershed

Background Information:

Drinking water comes from a variety of sources. Some of the water comes from water purification plants. Some comes from underground sources. Due to the diversity of the sources, the water we drink can differ greatly in quality and healthiness. The study of water is **limnology**. This involves physical, chemical, and biological conditions. Physical conditions refer to water temperature, stream velocity, and turbidity (clarity). Chemical conditions refer to the chemical make up of the water. This includes the amounts of dissolved oxygen, phosphate and nitrate. Biological conditions refer to organisms supported in the water such as bacteria, plankton, and fish.

Activity:

Step 1: Collect four large containers of water from four different sources such as: water from a local cave, river, tap or water fountain, and rain.

- Water from a local stream or river needs to be collected in clean, clear containers. (Remember that in order not to kill off microorganisms, containers cannot be kept tightly sealed for any length of time!)

Step 2: Ask students, "What are some indicators of water quality?" Write their answers on the board. Explain to students that they will be performing several tests to determine the quality of a sample of water.
Step 3: Distribute and read the 9-12 NASA explores article, "Water: It's Not Just for Drinking."
Step 4: Discuss what would be important to do if the astronauts needed to recycle water (removal of pollutants). Emphasize the need for the proper pH level (U.S. standards call for a pH of 6.5 to 8.5).
Step 5: Distribute the Student Sheets and the materials.
Step 6: Go over the instructions for the kits and pH paper with the students. Stress to students that they must wear safety goggles and gloves at all times when working with chemicals and unknown water sources. Remind students to wash hands after contact with any unknown water sources.
Step 7: Go over safety instructions (that is, any water spilled must be cleaned up immediately to prevent slips and falls). None of the materials are dangerous if proper lab safety guidelines are followed.
Step 8: Students should work in groups of two. Each student should have 2 of his/her own samples of water to test.
Step 9: Students will test each sample for:

odor
clarity/color
phosphates
pH
fecal coliforms
observe through a microscope for bacterial forms
total dissolved solids, like salt, using a conductivity tester (with assistance from the teacher). Be careful to avoid electric shock!

Modification: It may be appropriate to use the article and associated questions (Steps 3 & 4) as homework or save that activity for students that finish the lab early. Students with learning disabilities may require more time to finish the lab.

Student product: Students will fill out the Data Table and answer several data analysis questions. The table and questions are weighted out of 100 points to facilitate student evaluation.

Closure:
Go over the results of the tests with students orally and explain what each test might indicate.

- **Bad odor** – could indicate sewage pollution, algae. Chlorine odor could indicate treatment from a sewage treatment plant.
- **Clarity/color** – poor clarity could indicate dissolved (suspended) solids, like silt or soil in the water.
- **Phosphates** – if phosphates are present, they could indicate the presence of fertilizers, wastewater (detergents, sewage, etc.), or industrial discharges. These lead to algae blooms and plant blooms that consume carbon dioxide (CO2) and kill everything in the water.
- **Acidity (pH)** – most biological systems use pH at approximately 7.1. A low pH (acidic, below 5) or high (alkaline, above 9) may kill eggs, larvae, nymphs,

hatchlings, etc., as well as leach toxic heavy metals from soils and rock.

- **Fecal coliforms** – these are bacteria derived from human feces, mainly E. coli. See the direction kit for levels. (High levels indicate contamination, possibly sewage being too close to the water supply.)
- **Microscope observations** – some bacteria are normal and harmless. But, it is interesting to see what kind of "critters" are in the water we drink.
- **Total dissolve solids** (conductivity) – if your sample is conductive—or the degree to which it is conductive—it tells you the degree of particles present in your sample. For example, the more salts the more conductive the sample.

Evaluation:

Students should be evaluated on lab safety, procedure, and data analysis. The table and questions on the Student Data Sheet are weighted to facilitate grading.

Extensions:

1. Have students bring in tap water from their homes to test.
2. Test samples of water that are contaminated, and then run them through a water purification system. Retest the water to see the effectiveness of the purification system.

Is Your Water Clean?
Lab Procedure

Materials

- Goggles (per student)
- Rubber gloves
- Phosphate test kit and directions
- Coliform test kit and directions
- pH paper
- Student Data Sheets
- Alcohol (for hand cleaning)
- Electronic Sensor (electrodes to test for current conduction through water)
- Microscopes
- Glass containers to hold water samples (four per group)

Procedure

1. Choose one of the water samples to test. Each team member will test 2 samples.
2. Test the odor of your water sample by smelling it. Record your data on the Data Sheet. Write any conclusions you can make from the scent of the water in the conclusion section of the Data Sheet. Pure water has no odor.
3. Test the clarity/color of your water. Record your data and any conclusions you can make. Turbidity refers to the opaqueness or cloudiness of water—the muddier the water, the more turbid it is. Suspended solids in the water create turbidity, which can be measured by how much light is blocked or absorbed.
4. Carefully read the directions for the phosphate test kit. Perform the phosphate test on your water sample. Record your data and any conclusions you can make. Phosphorus is one of the key elements necessary for growth of plants and animals. Rainfall can cause varying amounts of phosphates to wash from farm soils into nearby waterways. Phosphate will stimulate the growth of plankton and aquatic plants that provide food for fish. This increased growth may cause an increase in the fish population and improve the overall water quality. However, if an excess of phosphate enters the waterway, algae and aquatic plants will grow wildly, choke up the waterway and use up large amounts of oxygen. This condition is known as eutrophication.
5. Using the pH paper, test the acidity of your water sample. Record your data and any conclusions you can make. A pH range of 6.0 to 9.0 appears to provide protection for the life of freshwater fish and bottom-dwelling invertebrates.
6. Carefully read the directions for the coliform test kit. Perform the coliform test on your water sample. Record your data and any conclusions you can make.
7. Look at a drop of your water sample under a microscope. Look for bacteria and other "small creatures" in your water sample. Record your data and any conclusions you can make.
8. With the assistance of the teacher, check for total dissolved solids, like salt, using a conductivity tester. **Be careful to avoid electric shock!** Record your data and any conclusions you can make.

Name: ______________________________ Date: ____________________

Is Your Water Clean?

Student Data Sheet

Water Sample: ________________________		
Test	Results	Conclusions
Odor		
Clarity/Color		
Phosphates		
pH		
Fecal Coliform		
Bacteria		
Conductivity		

Water Sample: ________________________		
Test	Results	Conclusions
Odor		
Clarity/Color		
Phosphates		
pH		
Fecal Coliform		
Bacteria		
Conductivity		

Data Analysis:

Over 2 million people rely on groundwater from karst aquifers in central Texas. Due to the high porosity and permeability of karst landscapes, inputs such as rain, streams, and rivers influence groundwater quality. Use data gathered from this lab and your knowledge of central Texas to answer the following questions.

1. Which water sample was the most polluted? In what way?

2. Which indicator of water quality did you find to be the most useful in determining the level of contamination? Why?

3. Name three major sources of pollution that threaten water quality. Explain how you came to your conclusion.

4. In paragraph form, explain why it is important to frequently test groundwater quality.