# Lesson Plan: Measuring Water Quality

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| Objective | Main Goal:<br>• Students will understand that water quality can be evaluated quantitatively using many parameters including conductivity.<br>Subsidiary Goals:<br>• Students will understand that water quality differs depending on environmental conditions and human activities that may affect it.<br>• Students will understand how a conductivity meter works and what it measures in water to tell us about its quality.<br>• Students will understand how measurements at many locations can tell us about the overall water quality of an area and help to determine the cause of poor water quality.<br>• Students will understand that the color of water is not necessarily indicative of its quality. |
| Assumed Knowledge | It is assumed that student have knowledge of the following:<br>• Different types of bodies of water including rivers, streams, ponds, lakes, and oceans.<br>• Bodies of water are connected by moving water in rivers and streams.<br>• Pollutants end up in our waterways when they are dumped there intentionally, when they are carried over the land surface via precipitation, and when rivers and streams carry them to new locations.<br>• What a hypothesis is and where it lies in the scientific process. |
| Background | There are a wide variety of inorganic substances or dissolved solids in water solutions. Common dissolved substances are sodium, chloride, sulfates, calcium, bicarbonate, nitrates, phosphates, iron, and magnesium (Reed, 2017). All of these materials at certain concentrations are essential for aquatic life and all have the ability to carry an electrical current. These substances affect the flow of materials in and out of the cells of organisms living in the water and they may also be used as energy sources in certain organisms. The dissolved substances in addition serve as parts of the molecules needed for building new cells.<br><br>Pollution may cause the levels of dissolved solids to fluctuate, so some organisms may be harmed during these times because their bodies are unable to adjust (Reed, 2017). Some examples of activities that can pollute the water are wastewater discharges that are high in salts, brine waters from oil production activities, irrigation, or clearing the land near a stream, overuse of fertilizers, or the spreading of road salt during icy |

conditions. Salt pollution can be a direct problem for humans when drinking water supplies have levels of salt over 0.5 ppt. Streams with high salinity may be unsuitable for agricultural or industrial use.

Total dissolved solids (TDS) is defined as the quantity of dissolved material in water (Reed, 2017). For bodies of freshwater in nature, it depends mainly on the rocks and soils that come into contact with the water and dissolve into the water. Measuring the total dissolved solids in water can tell us about its quality. For instance, water that flows through limestone and gypsum dissolves calcium, carbonate, and sulfate, resulting in high levels of total dissolved solids.

Many minerals are required to support living organisms in waterways and benefit human health in certain levels in our drinking water. However, some dissolved solids are considered pollutants because they are toxic to living organisms including humans or the chemicals are too abundant in waterways and so they become toxic.

A convenient way to measure TDS is to test the conductivity of the sample. Conductivity is a measure of the ability of water to pass an electrical current and is affected by the presence of dissolved solids (Reed, 2017). As the level of dissolved solid materials rises, the conductivity value will also increase. Water with very little dissolved material will produce a low conductivity value. Discharges to water can change the conductivity. A failing sewage system could raise the conductivity because of the presence of chloride, phosphate, and nitrate. A farm nearby that applies chemicals to its fields or wastewater emitted from a factory could increase conductivity. An oil spill would lower the conductivity because oil does not conduct electrical current very well.

Conductivity is measured in microsiemens per centimeter, µs/cm (Reed, 2017). Ultra pure water has a conductivity close to zero, generally less than 1 µs/cm because in theory no other substances have been dissolved in it (Adum, 2015). Safe drinking water has a conductivity in the general range of 100-1000 µs/cm where the dissolved substances are generally minerals and nutrients, not toxic pollutants. Salt water in oceans and marshes can range from 1000-100,000 µs/cm due to the high quantity of salt and other minerals dissolved.

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| Materials | • Four white or transparent cups of containers to hold water samples<br>• Tap water<br>• Sugar, salt, and/or powdered spices (see sample preparation)<br>• 3 spoons, or other utensil for mixing<br>• Handout<br>• Slideshow<br>• About 45 minutes (20 minutes for a slideshow, and 25 minutes for the handout activity) |
| Activity Procedure | 1. Use the slideshow and notes to provide students with background water quality and how it can be measured using conductivity.<br>2. Divide the students into 3 or 4 groups. Distribute one handout to each student.<br>3. As students answer the first question defining conductivity, space the prepared water samples paired with a stirring utensil at the front of the room. If possible, place the samples on light colored surfaces or white sheets of paper to make the color of the samples more visible.<br>4. As students are making their hypothesis (Question 2), distribute to each group one water quality probe, one rinse cup filled with clean tap water, and a napkin or paper towel to dry the probe in between uses.<br>5. Instruct the groups to take turns testing each water sample, having a new student use the probe at each sample.<br>6. After students finish the handout, have a short discussion using the follow-up questions below.<br>7. If possible, it could be a fun activity to bring the conductivity meters outdoors to test the water quality of a nearby stream or pond.<br><br>Note: This activity can be done with students preparing the water samples themselves before completing the “Measuring Water Quality” handout. |
| Sample Preparation | Prepare the water samples in white or translucent containers. Using room temperature water is recommended (about 20-25 degrees Celsius) to ensure quality readings from the meters, so filling the containers well before class time is recommended.<br><br><u>Best Option</u><br>Sample 1: Mix one teaspoon of brown sugar or ½ teaspoon of a powdered spice, such as cayenne pepper, turmeric, paprika, or other spice with color, into 8 ounces (1 cup) of water. The spice will likely not dissolve, and so the sample should be stirred again before showing the students to make their initial hypothesis and before testing the conductivity.<br>Sample 2: Mix one half teaspoon of salt into 8 ounces (1 cup) of water until dissolved.<br>Sample 3: Fill a glass with 8 ounces of tap water. |

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| | <u>Alternative Options</u><br>To be used if the above supplies are not available.<br>Sample 1: Mix 1 teaspoon of sugar into 8 ounces of tap water until dissolved.<br>Sample 2: Mix 1 tablespoon of sugar into 8 ounces of tap water until dissolved.<br>Sample 3: Fill a glass with 8 ounces of tap water.<br><br>Sample 1: Mix ½ teaspoon of salt into 8 ounces of tap water until dissolved.<br>Sample 2: Mix 2 teaspoons of salt into 8 ounces of tap water until dissolved.<br>Sample 3: 8 ounces of tap water.<br><br><u>Important</u>: Confirm Results<br>Test the conductivity of the samples before students use them to ensure the results below. Mix in more of the spice, sugar, or salt to make the conductivity value higher.<br>Sample 1 has a middle value between Samples 2 and 3<br>Sample 2 has the highest conductivity<br>Sample 3 has the lowest conductivity.<br><br>Note: You could add to this activity by having students prepare the samples to practice laboratory skills. Simply print the relevant sample preparation instructions above and provide students with containers and room temperature water. |
| Follow-up Discussion | Start by asking students what sample they hypothesized would have the highest conductivity (lowest water quality). Why did they make that hypothesis? Was it correct?<br><br>If time allows, have a few students share their answers to questions 2, 3 and 4, and explain their reasoning. |

References

Adum, A. (2015, February 23). *Understanding Water Conductivity*. Analytical Technology, Inc. https://www.analyticaltechnology.com/analyticaltechnology/gas-water-monitors/blog.aspx?ID=1106&Title=Understanding%20Water%20Conductivity

Reed, A. (2017). *Lesson 5: Water Conductivity and Total Dissolved Solids Water Quality Sampling - PDF Free Download*. https://docplayer.net/20986389-Lesson-5-water-conductivity-and-total-dissolved-solids-water-quality-sampling.html