SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Microbit Water Quality Testing	Grade 9 Biology

Lesson Plan

Coding Tool	Microbit
Cross-curricular	N/A

Big Ideas
People have the responsibility to regulate their impact on the sustainability of ecosystems in order to preserve them for future generations.

Specific Expectations
B2.4 plan and conduct an investigation, involving both inquiry and research, into how a human activity affects water quality, and, extrapolating from the data and information gathered, explain the impact of this activity on the sustainability of aquatic ecosystems.

Description
In this lesson, students will use a Microbit to test water samples for three different factors; temperature, turbidity and salinity. Students will be able to use these three tests to determine the quality of water.

Materials
- BBC Microbit
- Elecfreaks Microbit Smart Home Kit
- 3 Mason Jars
- Salt
- Distilled Water

Computational Thinking Skills
- Conditional statements
- Inputs and outputs
- Sensors
- Variables

Introduction
Water quality is measure of the condition of water based on common standards. By testing the quality of water, environmental engineers and technicians are able to determine if water is safe for human, domestic or industrial use. In this regard, water has to be tested after it is treated to ensure that it is meeting health standards and therefore is safe for its purpose.

Ambient water quality can also be tested which relates to surface waters for lakes, rivers and oceans. Evidentially, water plays a significant role in sustainable ecosystems and needs to be treated as such. The presence of toxic substances or certain microbes can be detrimental to human activities such as swimming, fishing and irrigation or to wildlife as water is a key part of their habitat. Ambient water quality tests are used to determine the best measures for protecting and maintaining healthy ecosystems.

When testing water, there are a wide range of indicators that are tested for in order to determine the quality of the water. These tests differ depending if it is for drinking or environmental purposes and there are dozens of physical, chemical and biological indicators to

consider. These can include alkalinity, colour, pH, odor, dissolved oxygen, total hardness and many more. The three tests that we can conduct with the Microbit are water temperature, turbidity and total dissolved solids. These are all physical indicators in the environmental sector.

Water Temperature: The temperature of water is one of the most common physical indicators. Temperature can have an impact on the chemical and biological qualities of water. One of the largest issues related to water temperature is thermal pollution, the introduction of warmer water from industrial or urban runoff. Uncharacteristically warm water reduces the level of dissolved oxygen and affects photosynthesis of aquatic plants and the metabolic rates of aquatic organism.

Turbidity: Turbidity in water is a measure of haziness caused by large numbers of particles. While some of this suspended matter is visible and large enough to settle to the bottom, small particles can remain suspended in water and cause it to appear turbid. When considering drinking water, turbidity is largely esthetic, but in the environment high levels of suspended particles can absorb heat and additionally scatter light, decreasing photosynthetic activity.

Total Dissolved Solids: While various inorganic and organic substances be dissolved in water, the most common factor tested for in freshwater systems is salinity. As salt is conductive, an electrical conductivity meter is typically used to measure the total dissolved solids in water. Salinity is a factor that influences the types of organisms that can live in a body of water, so it is important to test for total dissolved solids to ensure there are no drastic changes to an ecosystem.

Each of these tests are small components of water quality testing. In this lesson, students will code a Microbit to measure all three indicators. There are many different baselines to consider when testing water, so for the purpose of this activity, students will base findings off of comparative data.

Action

In this lesson, students will use a Microbit and some of the Smart Home Kit sensors to test three different water quality indicators.

The included handouts demonstrate the set-up and the code for the following three tests:

Water Temperature: Using the temperature sensor, the Microbit can make accurate readings in degrees Celsius. Using the Microbit, pressing the A button will record the temperature. Pressing the B button will display the temperature. When doing this test, be sure to contain the Microbit in a plastic bag to ensure that is not damaged by water.

Turbidity: To test for turbidity, the Microbit will use the LED as well as the light sensor. Since turbidity obstructs light, the level of light recorded by the light sensor is indicative of the number of particles in the water. The higher the value recorded on the Microbit, the more light there is that gets through, indicating less turbidity. To use this set-up, tape the light sensor and LED on either side of the jar of water. Press the A button to turn on the LED and record the light level. Pressing the B button will display the light level recorded and pressing both A and B simultaneously will restart the recording.

Total Dissolved Solids: The soil moisture sensor that is included with the Smart Home Kit acts as a conductivity meter. When coded properly, it can be used to test how conductive the water is, with the higher readings indicating a higher salt content. Simply place the gold tip of the soil moisture sensor into the water and observe the value on the plotted graph. The Microbit can also be coded almost identically to the water temperature test for this experiment.

Of the three sensors, the water temperature sensor is the only one that provides a quantitative result that can be used against water quality standards. The turbidity test and total dissolved solid test produce quantitative results but would need to be calibrated against actual water testing sensors to get accurate readings. What can be done however is use the results in a comparative manner. To test this, you can create three different samples in mason jars:

- Distilled water
- Tap water
- Salt water

To test the sensors created by the students, provide them with one of each of the samples, unlabelled. They can then use the different tests to determine which sample is which. The results should be as followed:

- Distilled water: lowest turbidity, lowest conductivity
- Tap water: average turbidity, average conductivity
- Salt water: high turbidity, high conductivity

Alternatively, you could use the Microbit and its sensors to test water quality at a local body of water and track its changes over time. Observe and comment on any changes noticed over time.

Consolidation/Extension

The handouts provide a complete procedure for programming each of the water quality tests. If you students are proficient in coding, they can be challenged to program the sensors on their own, or even find ways to improve it. An additional extension would to challenge students to see if they could use the sensors and the Microbit to conduct any other water quality tests.