Instructor Guide

Days 2 and 3: Diving into Water Chemistry

Overview

Introduce students to the equipment they will be using for the water chemistry portion of the investigation by conducting the Mystery Water Lab. Over two class periods, students will practice using multi-parameter probes, analyze their results, and connect their learning to planning for real stream monitoring.

Standards Alignment

AFNR Natural Resource Systems Career Pathway Standards, Common Career Technical Core (CCTC)

NRS.01. Plan and conduct natural resource management activities that apply logical, reasoned, and scientifically based solutions to natural resource issues and goals.

> **NRS.01.02.** Classify different types of natural resources in order to enable protection, conservation, enhancement, and management in a particular geographic region. (NRS.01.02.05.a., NRS.01.02.05.b., NRS. 01.02.05.c.)

Michigan Science Standards, High School Performance Expectations

HS-LS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Learning Objectives

- Students will develop a foundational understanding of how water chemistry affects water quality by analyzing and explaining key parameters, including pH, temperature, total dissolved solids, conductivity, and salinity, through conducting and interpreting results from the mystery water lab.
- Students will accurately operate multi-meters to measure and record water chemistry parameters, demonstrating proper calibration and data collection techniques.
- Students will design a field data collection plan to ensure consistent and accurate measurement of water chemistry parameters using appropriate tools and techniques.

Materials

- Stream Team Field Guide (1 per student)

- *Mystery Water Lab: Which Water Would You Drink??* Handout (1 per student or group)
- *Planning and Carrying Out the Investigation* Handout (1 per student or group)
- Writing instrument (1 per student)
- Oakton PCTSTestr 50 waterproof pocket pH/Cond/TDS/Salinity Tester (1 per group)
- Calibration standards for Oakton PCTSTestr 50 (for instructor use)
    - pH 4.00, 7.00, and 10.00 buffer solutions
    - 84 µS/cm and 1413 µS/cm conductivity standards
- Water samples labeled A-H (1 set of samples per group)
    - Drinking fountain water
    - Potable tap water
    - Non-potable tap water
    - Distilled water
    - Bottled drinking water
    - Propel water
    - Household well water (groundwater)
    - River water

Vocabulary

- *Conductivity* – the ability of water to conduct electrical current, which depends on dissolved ions from salts and inorganic chemicals.
- *Flow Rate* – the speed water moves past a given point in 1 second.
- *pH* – a measure of the acid content of water, ranging from 0 (acid) to 14 (base) with a neutral point of 7.
- *Salinity* – the amount of dissolved salts in water.
- *Temperature* – the measure of the hotness or coldness of an object or liquid.
- *Total Dissolved Solids (TDS)* – the amount of solid material that has been dissolved into the water, including minerals and salts.
- *Turbidity* – a measure of the clarity of water.

Advanced Preparation

1. Prior to the lab, the instructor should calibrate probes and check batteries.
2. Prior to the lab, collect mystery water samples in clean containers using appropriate sample collection protocols; label with ID letters. Create a sample key with the ID letters.
3. Set up testing stations with all necessary probes, sample cups, and data tables.

4. Print copies of or share links to the *Mystery Water Lab: Which Water Would You Drink??* Handout and the *Planning and Carrying Out the Investigation* Handout.
5. Assign students the "Diving into Water Chemistry" section from the Field Guide as homework to prepare them for an in-class discussion on water chemistry.

Lesson Sequence

Time period: homework (reading) prior to class and two class periods, both completed in classroom.

Day 1 – Mystery Water Lab

Engage: Introduction to Water Chemistry Parameters & Multi-meter Probes (15 minutes)

1. Briefly review the major water chemistry parameters that will be collected with the multimeters (pH, temperature, TDS, conductivity, salinity).
2. Discuss how these parameters help us detect natural, biological, or human influences that affect water quality.

   Sample discussion questions:
   - *Which of these do you think changes if a stream is polluted?*
   - *What human activities might affect these measurements?*
3. Model multi-meter probe operation through showing students how to: turn the probe on/off, switch between measurement modes (pH, temperature, TDS, conductivity, salinity), and rinse the probe between samples to avoid contamination. Conduct a brief discussion of the necessity of rinsing the probe between samples.

   Sample discussion questions:
   - *Why is rinsing between samples necessary?*
   - *What types of errors do you think could occur if the probe is not calibrated?*
   - *What would you do if the probe displayed an unexpected reading?*

Explore: Mystery Water Sampling Activity (35-45 minutes)

1. Organize students into small groups based on the number of probes and samples available. Ensure that each group has a full set of materials.
2. Review safety and lab procedures. Remind students not to taste any water samples. Review proper use and cleaning of probes between samples. Demonstrate one full test with a sample so students know how to record data.
3. Have each group tests all mystery water samples for the assigned parameters. And carefully record all results in the data table on the *Mystery Water Lab: Which Water Would You Drink??* Handout. Then, once all data has been collected, have students

determine the sample identities and circle their "most drinkable" sample based on the data collected. Remind students no samples should be tasted.

4. Students should then complete the lab follow up questions.

Wrap-Up Reminder (5 minutes)

1. Let students know they'll discuss their results and connect them to real stream monitoring tomorrow.

Day 2 – Discuss, Reflect, and Plan

Explain: Discussion and Sharing (20 minutes)

1. Have each group share their chosen "most drinkable" sample and explain their reasoning. Then, the instructor should reveal the true identities of the mystery samples.
2. Have groups reflect on their lab experience from the previous class. Guide a discussion about the lab, connecting the experience to environmental water quality monitoring.

   Sample discussion questions:

   - *Which parameters were most helpful?*
   - *Which results were surprising?*
   - *How did this lab prepare you for field testing?*
   - *In the field, what natural or human factors could explain big differences between water samples?*
     - Reinforce the idea that abnormal water chemistry data or big changes in data between sampling days could mean a pollutant is present.

Elaborate: Planning and Carrying Out the Investigation (35 minutes)

1. Connect the mystery lab activity to the *Planning and Carrying Out the Investigation Handout* by letting students know they will be conducting water quality analysis in the field using the same multi-meters used in the lab. Connect the lab to the field work and invite students to practice thinking like scientists, identifying key variables, and planning an effective investigation.
2. Guide students through the handout by giving about five minutes for question one, followed by about five minutes of class discussion before moving on to the second question on the handout. Repeat this procedure for questions two and three.
3. Reinforce how today's planning work connects directly to the upcoming field investigation and water quality analysis.
4. Answer any remaining student questions about the equipment or process they will use in the field.