Sponsored by Wayne State University, Michigan Technological University and Belle Isle Conservancy with funding from the National Science Foundation

<https://www.biaquariumstem.org/lesson-plans1.html>

*It’s Time for a Water Check-Up -- You Be the Doctor!*

By Connie Atkisson, Thirkell Elementary-Middle School conniecoolest@aol.com

Lesson Overview:Students will examine water to determine its quality for drinking or for aquatic organisms to live in it. Several samples of water will be provided for students to examine visually. Students will investigate whether simple visual observations are enough to determine the safety of water for human consumption or for organisms to live in it in the environment. Next students will look online to find out:

* Which entity ensures the safety of their drinking water?
* Which water quality tests must be performed to ensure that their drinking water meets minimum standards for specific water quality parameters?
* What tests are used to test if the water in city rivers and streams is safe for fish or for people ?
* Students will develop a hypothesis to answer the question*: Is my community’s drinking water healthy enough for human consumption?* Students will also consider *Is the water in nearby rivers and streams safe for fish and people?*
* Next, students will perform the water quality tests that they identified to collect the data to help answer their hypothesis.

Teacher Background: The source and quality of a city’s drinking water determines how much treatment is necessary to make it palatable (taste, odor and clarity) and safe for human consumption. The rivers in the Detroit area have been impacted by past and present industrial discharges—they have been heavily polluted over the years. Students need to understand that just because water looks clean doesn’t mean that it is. An easy way to determine the health of water is to look at the benthic macroinvertebrates and to conduct simple tests that can tell the tester what the level of health is for the water they are examining. Most of the resource information that you will need can be found on the LaMotte website listed under the resource section of this lesson plan.

Target Grade & Subject: Gr. 5, general science, hydrosphere, water quality, environmental sciences

**Instructional Setting:** classroom with Internet access; field study area; lab, if available.

**Advance Preparation G**ather several sources of water, one of each for each group to use. This can be bottled water, from a river or pond or puddle, school, home, and anywhere else that you can think of, as long as it is a variety of sources. Preferably, source water can be obtained from a lake or river or groundwater that supplies your local community.

**Learning Objectives**

*Students will be able to:*

1. Properly perform several of the nine basic water quality tests (pH, dissolved oxygen (D.O.), phosphates, water & air temperature, nitrates, turbidity, conductivity, and total dissolved solids). For those that cannot be performed for various reasons, a formula is available to calculate health based on the weighted tests. This is included in the resources.
2. Interpret results gathered from data to determine if their hypothesis can be supported or invalidated.
3. Develop a hypothesis and design an experiment that will answer the question addressed by their hypothesis.
4. Properly record data in journal/logbook.

**Michigan Science Performance Expectation** (<http://ngss.nsta.org/Professional-Learning.aspx> )

**Next Generation Science Standards (NGSS) Addressed:**

Students who demonstrate understanding can:

|  |  |
| --- | --- |
|  |  |
| **MS-ESS3-3** | Apply scientific principles to design a method for monitoring and minimizing human impact on the environment |
| Science and Engineering Practices[Constructing Explanations and Designing Solutions](http://www.nap.edu/openbook.php?record_id=13165&page=67)[Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.](http://www.nap.edu/openbook.php?record_id=13165&page=67)* [Apply scientific principles to design an object, tool, process or system.](http://www.nap.edu/openbook.php?record_id=13165&page=67)
 | Disciplinary Core Ideas[ESS3.C: Human Impacts on Earth Systems](http://www.nap.edu/openbook.php?record_id=13165&page=194)* [Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.](http://www.nap.edu/openbook.php?record_id=13165&page=194)
* [Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.](http://www.nap.edu/openbook.php?record_id=13165&page=194)
 | Crosscutting Concepts[Cause and Effect](http://www.nap.edu/openbook.php?record_id=13165&page=87)* [Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.](http://www.nap.edu/openbook.php?record_id=13165&page=87)

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -  Connections to Engineering, Technology, and Applications of Science [Influence of Science, Engineering, and Technology on Society and the Natural World](http://www.nap.edu/openbook.php?record_id=13165&page=212)* [The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.](http://www.nap.edu/openbook.php?record_id=13165&page=212)
 |

**Materials & Quantities Needed** per class and per student group

*Per class*

* Laptop computer, video projector, internet access or previously downloaded video
* PowerPoint presentations included with the lesson:
	+ (1) *Scientific Tools for Water Quality Testing*
	+ (2) *Setting up for Data Collection*
* *Video: Charlie LaDuff Canoes the Rouge River* (on YouTube)[*https://www.dailymotion.com/video/x2m4fdj*](https://www.dailymotion.com/video/x2m4fdj) (15:30)

*Per student group*

* Several water samples for each table, per class-- these can be bottled water, river, pond, puddle, or school fountain water -- but should be from a variety of sources.
* LabQuest units, fully charged, probes (pH, temperature, DO, conductivity)-- one set per table if available OR LaMotte water quality test kits for Phosphates, Nitrates, Copper, and extra test kits for additional uses.
* Paper towels, **container labeled waste water,** goggles for each student, journals/logbooks, pens, pencils
* copies of LaMotte test kit instruction cards enlarged and laminated
* Information about the *“Nine Basic Water Quality Tests.”* These can be found at <http://www.pathfinderscience.net/stream/cproto4.cfm> and other sources. Have enough for each team or partners (your choice).

**Driving Question: How Can We Determine the Health of a Body of Water?**

**5E Model**

**ENGAGE: (one class)** Show the video *“Charlie LaDuff Paddles the Rouge River”* (15:30). Explain to the students that this is a video that shows what has happened to a major river that affects where we live and at one time it was considered the most polluted river in all of Michigan. Upon completion, have students generate questions that they would like to explore relating to knowledge gained from watching the video. (Note: if you would like to prepare for potential student questions about how the Rouge is now, look at a recent Rouge River report ( <http://www.allianceofrougecommunities.com/PDFs/rrac/2013RougeReportCard.pdf> );the Rouge is greatly improved during the last twenty-five years, but still has lots to improve.).

 During this video, students will record in their journals at least three issues that the travelers mention that are problems with the river.

**Expected prior knowledge:** *Students should know what pollution and environmental issues mean.*

**EXPLORE:** (two classes):

Day One: in computer lab or classroom (if computers available*)* each student will research answers to a question chosen by their team from the class list generated.

**Supporting students during exploration:** *Teacher can ask:*

* What information will help you answer this question?
* Who can you ask that will help you answer this?

Day Two: Classroom setting: Each team (or partner pair) receives copies of the article on water quality testing (Why We Measure…). Each team should read about one test and be prepared to report to the class about its value and importance. (If you only have the Water Monitoring Kit, this information can be found in the little manual and printed out for student use).

**EXPLAIN**: (One class period) Each student will list their 3 main points of research from their individual research papers on a whiteboard and share with the whole class. Student teams will also explain their water quality test results as well.

**ELABORATE:** (Three class periods)

**(Day One & Two)** Using talk moves ( https://www.inquirybydesign.com/talk-moves-create-a-culture-of-talk-fostering-student-talk-and-classroom-dialogue-part-3/), teacher will guide the discussion about how we can also determine the health of a stream or river ecosystem by examining the benthic/aquatic organisms that live there. A list of major ideas from the class discussion can be added to a Driving Question Board.

 **A pre teaching lesson is necessary here for students to understand two points: i) “How to set up a data log for gathering data collected” and ii) “how to properly use scientific tools in a safe and proper manner**”.

Show the first PowerPoint called **Scientific Tools** **to Assess Water Quality** and guide students into examining these tools and how they should be used. Have examples in the classroom for them to experiment with after the PowerPoint. After viewing the PowerPoint, have students take turns identifying the actual instrument by holding them up and asking for their names and purpose. Then give students a chance to work with them. Suggest they draw them in their journal so they can identify them later.

 Secondly, show them the pdf on **Setting Up For Data Collection in their journal.** Have them follow along and write the appropriate things in their journal for future reference.

**Supporting students during elaboration:** *Ask the following as you walk around the students:*

* What would help you record this information?
* What would you need to perform this experiment?

**Day Three:** classroom setting

 Provide each team with samples of the water you have collected and with tools for measuring water quality data. Ask student teams to create a hypothesis about the samples they are going to test and record this hypothesis in their journals before beginning testing. Each team should then perform ALL of the tests you have available and record their data for each water sample they have been given. Remind them that each team has different samples and their data will not be the same. (This should eliminate any copying of data from others.) This is still the practice for the pre teaching lesson so I am looking to see if they can properly perform the tests to obtain accurate data. The next time will be on the field trip extension where I am looking for data.)

**EVALUATE:** Students will be assessed by/through:

* their demonstration of proper use of the data collection tools and test kits.
* presentation of the whiteboard information
* group presentation of test value as weighted by drinking water standards.
* journal entries and accuracy of data gathered
* creation of a PowerPoint (4 slides max) that shows their data collected and placed into graph form
* oral quizzing on tool identification and purpose

**Supporting students during evaluation:**

* Is there something you need to fulfill this evaluation?
* Where can you look for the necessary information?

**New Vocabulary:**

water quality, hypothesis, scientific tools, LabQuest, probes, pH, Dissolved Oxygen, benthic, macroinvertebrates. phosphates, nitrates, temperature, sample, data, journal, aquatic, organism.

Safety Considerations

Students should always wear safety goggles and plastic gloves when performing chemical tests. Depending on where you obtained your water samples, you may also want to have them wear goggles the entire time. Gloves should also be worn when using a dissolved oxygen chemical test. Provide a waste water container to discard samples after the chemical test. Stress the importance of proper disposal, cleaning and care of equipment, and wash hands when finished.

**Sources**

***Charlie LeDuff Canoes the Rouge River (Most Polluted in Michigan)*** <https://www.youtube.com/watch?v=cUO0VpJ3Pg4> This is a free documentary that shows how the Rouge River has been polluted. Since it empties into the Detroit River, it shows some amazing footage near the end where you can see the murky, heavy metal laden waters out by Zug Island. (Information about improvements in the water quality of the Rouge River during the last 25 years can be found in a report obtainable through the internet at <http://www.allianceofrougecommunities.com/PDFs/rrac/2013RougeReportCard.pdf> . The report is very graphic, showing maps that compare river quality markers from twenty-five years ago to current maps of the same markers. Although much of the Rouge is greatly improved, the final stretch of the river, from Dearborn to Zug Island especially remains of concern by almost all measures.)

**Bill Nye the Science Guy and Water Pollution** <https://www.youtube.com/watch?v=gT3V9OeXOl8&list=PL57E40E7F953107E7>

**LaMotte Instruction Manual** <http://www.lamotte.com/images/pdf/instructions/1603.pdf>

This manual is great for helping both students and adults to understand pH and its interaction with water. Pgs 3-4 are especially useful as they give a diagram of pH levels and relationship to common household substances.

* field trip to Belle Isle to collect water samples and to visit/receive training at the Belle Isle Aquarium to examine benthic macroinvertebrates. (lesson extension)
* field trip to waterworks plant to see how raw water is treated to become drinking water for communities. (lesson extension)

**How To Run A Silent Debate**

 <https://www.facinghistory.org/resource-library/teaching-strategies/big-paper-silent-conversation>

**Detroit Water History**

<http://www.dwsd.org/downloads_n/about_dwsd/history/complete_history.pdf>

This is great for background reading to enhance teacher and student understanding of how the infrastructure came to be and how it led to today’s water system.

*Appendix*

**Supporting Materials:** data sheets, PowerPoint slides

* WATER QUALITY Resource Notes (data sheet for computer lab)
* Scientific Tools ppt
* How To Set Up for Data Collection pdf
* Nine Basic water tests (pdf) (Rouge Education Project)
* Friends of the Rouge (FOTR) Water Quality data form for weighting tests (REP) attached to this lesson—next page.



 (FOTR)

FOTR contact information:

FAX: 734-927-4920

 friends@therouge.org

 650 Church St, Suite 209

 Plymouth, MI 48170

An on-line water-quality index calculator (recommended by FOTR), using similar variables, can be found at:

<https://www.water-research.net/index.php/water-treatment/water-monitoring/monitoring-the-quality-of-surfacewaters> See also: <https://drive.google.com/file/d/1XFRgVX41r82_LtRkClhin7gR_1iY7wmL/view> . Definitions of each of the parameters can be found at <http://www.pathfinderscience.net/stream/cproto4.cfm> .