What's in my Water?!?!

Grade: high school | NGSS: HS-ESS3-4, HS-ETS1-1 | SEEd: ESS 4.1 & 4.4 | Lesson time: 70-90 Minutes

Lesson Level Performance Expectations

- Students will obtain information about different systems that are in place to make water safe for consumption. They will communicate their findings through a method of their choosing with a R.A.F.T (Role, Audience, Format, and Topic) assessment.

What Students Will Figure Out:

- How water filters work and what sizes of particles are removed
- Concerns with chemical contamination from metal and plastic containers
- Compare methods for removing oil from water
- Untreated water can contain microbes

Lesson Snapshot:

In this lesson, students will be introduced to a phenomenon that shows them how water can look like a clean source but have hidden things that could cause harm. Students will then be grouped and have a chance to explore four stations: 1) A station where students will attempt to remove oil from water using different means to figure out which works most effectively. The students will also theorize where oil spills may happen in their water system in Utah and how that can affect the groundwater or reservoir where they obtain their water. 2) Students will use a chemical testing kit to test if a Stanley mug is contaminated with lead. They will then look through information about different containers that are safe for consuming food or drink. They will learn about proper recycling methods for plastics. 3) Students will look through a microscope at two samples of pond water: untreated pond water floating around microbes and the same pond water chemically treated to kill any microbes. The students will then be asked if they would still drink the water. 4) Students will learn how filters work by creating a macroscopic example of a filter using different sizes of plastic beads and salt to filter each into separate piles. Then, students will learn about different sizes of filters and see which filters will work best for each other's stations. The overarching goal for students is to see what water must go through to be clean for human consumption.

Phenomenon

Students will observe two glasses of liquids - one clear and one cloudy/dirty. On the paper, students list what they notice (describe thoroughly), what they wonder (what questions they have), and then a place to list the actual contents.

The actual content:

A - water with chocolate milk and some herbs/tea

B - water with salt

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Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtain, Evaluate, and Communicate Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. • Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.	**Water Pollution 4.1 and 4.4** 4.1 Resource availability has guided the development of human society. All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. 4.4- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	**Systems** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Materials

Student Materials	Teacher Materials	Other Resources	
Student worksheet	- Water Pollution-Station Papers - Water Pollution R.A.F.T. - Plastic Articles Info (for chemical contaminants station)	**Phenomenon** - 2 Cups - Salt - Chocolate Milk **Station Materials** **Oil** - A open container - Vegetable oil - Water dye - Sponge - Cotton Balls - Hair wrapped in a single-use sock (obtain hair from a local hair stylist) - Plastic Pipet	**Microplastics** - Plastic Beads - Small plastic beads - Salt - Container - Filter paper sized to filter out each size of bead separately (use hole-punched paper, kitchen strainer, coffee filter) **Microorganism** - Microscope - Bacteria infected pond water - Water purification tablet or bleach **Chemical Contaminants** - Stanley Mug (or off-brand) - Lead testing swabs - Plastic examples with multiple plastic recycling numbers.

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Lesson Preparation

Material Preparation

Previous Knowledge:
Grade 8 strand 4: Humans depend on Earth's land, ocean, atmosphere, and biosphere for many resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet due to past geologic processes.

Grade 6 strand 4: Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. However, changes to Earth's environment can have different impacts (negative and positive) on different living things.

As human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies are engineered otherwise.

Material Setup (20-30 Minutes):
Phenomenon – In two cups, add about half a teaspoon of chocolate milk, making it look dirty, and in the other, add as much salt as will dissolve, keeping it clear but taste horrible.

Stations:
Oil – Mix water with dye and add oil to the water mixture, leaving it in the open container. Leave all other materials and instructions so they are accessible. To test the efficacy of human hair, cut hair (obtained through a local salon ahead of time) should be put into individual nylon stockings. Each group will need a fresh, unused, hair-filled stocking. The station will also need cellulose sponges, pipettes, and cotton balls.

Microplastics – Mix both beads and salt, leaving them in a container. Leave filters and station instructions accessible for students.

Microorganisms – Prepare slides of the dirty pond water and the water after it has been treated. Focus on the microscopes. Leave the station card near the microscopes.

Chemical Contaminants – Place the Stanley mug with the lead testing swabs by each other. Leave the plastic containers out for the students to examine. Leave the station card near the Stanley mug.

Experience the Phenomenon or Experience the Problem

What Students Are Doing

Ask for student volunteers to taste the contents of the cups. It could be one volunteer tasting both or two volunteers.

Teacher Guidance

Suggested prompts

Ask volunteers to describe what they are tasting.

- Is this clear, clean water, from what you can taste?
- Does it taste how you expected?
- How can we tell when water is unsafe to drink?
- When water isn't safe to drink, how can we clean it?
- What are some things that make water unsafe or undrinkable? (students should list this on the student sheet)

Listen for:

Listen for students demonstrating understanding that the way water looks is not always a good indication of how clean it is. If the students do not bring this up, guide the conversation there.

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Additional Guidance

IT MIGHT BE IMPORTANT TO ASSURE STUDENTS THAT NOTHING IN THE CUPS WILL HARM THEM. REITERATE THAT YOU WOULD NEVER WANT THEM TO DRINK DIRTY WATER AND RISK SERIOUS ILLNESS. DON'T DRINK THE POND WATER, FOLKS!

Investigate and Model the Phenomenon

What Students Are Doing

Students will go to stations to obtain information about different types of water pollution and evaluate what is done to address them within our water system. Station guides are printed and laminated, giving students directions at each station. As they complete activities at each station, students will answer questions on their student worksheets.

Ten minutes per station is suggested.

*** It is HIGHLY recommended that the teacher discuss the stations and give directions BEFORE students go to the stations. A brief overview and general instructions should allow students to go through the stations more smoothly.

Stations:

Oil - Students will evaluate different ways to clean oil off water's surface: cotton balls, micropipettes, human hair in a nylon sock, cellulose sponge, and soap. Using a different method for each container, students will try to get all the oil off the surface of the colored water, comparing the efficacy of each. They will answer questions on their student worksheet.

Microplastics - Students will model microplastic filtration (on a macro scale) using different sizes of beads and salt and several different filter sizes (colander, strainer, and coffee filter). The goal will be to set up the various filter sizes to separate the different sizes of beads effectively. They will answer questions and draw their setup on the student worksheet.

Microorganisms - Students will look at pond water under the microscope, in addition to a sample that has been boiled and one that has been treated with a water purification tablet. Depending on teacher preference, the samples could be altered to include just pond water and treated or boiled pond water. As filtered water might be uninteresting to view, it could be omitted. Students will answer questions on their papers and draw what they see under the microscope.

Chemical contaminants - Students will test a Stanley (or comparable container) for lead. They will also determine which plastics are considered "safe" and which ones should be avoided, according to plastic identification codes. They will look for recycle codes on various plastic containers, list them, and use the station guide to determine the type of plastic. Students will answer questions about plastic safety.

Teacher Guidance

1. **These activities require additional instruction and supervision. As some are messy and can be difficult for all students to accomplish unassisted, we recommend doing this activity when extra help and supervision can be provided.**
2. As the stations require preparation and setup, we recommend that the teacher gather plastic containers with various recycle codes in advance. Additionally, getting cut hair from a local salon must be done beforehand.
3. The teacher may choose large or small groups depending on class size. Setting up multiple identical stations may be advisable to keep group sizes small.
4. It is HIGHLY recommended that the teacher discuss the stations BEFORE students go to them.
5. Setting a 10-minute timer that students can see will allow students to know how much time they have remaining.

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Suggested prompts

Oil station:

- What do you expect will be most effective?
- How will you be able to determine which method is most effective?
- When could this be applied outside the classroom?
- Why would soap be used to clean up an oil spill?
- What are the dangers of using soap to clean up an oil spill?

Microplastics station:

- How can you set up your filters to sort the beads according to size?
- Why would a filter start by filtering the largest particles? Why not start with the smallest?
- How are water filters built to maximize efficiency in removing particles?

Microorganisms station:

- What would you expect to see in boiled pond water? Why?
- What would you expect to see in filtered pond water? Why?
- Why would boiled and filtered water look different under a microscope?
- How long do you think you would need to boil water to kill microorganisms?
- Does boiling water remove all harmful contaminants?

Chemical contamination station:

- Are there places in the United States that do not have safe drinking water? What makes it unsafe?
- Have you ever been given a boil order where you live?
- Have you ever noticed the triangles with numbers in them? Do you know what they mean?
- Is it reasonable for a person to never microwave plastic? Why or why not?
- If plastic is unsafe in the microwave, what should be used instead?
- If Stanley mugs have lead in them, how could they be safe for drinking?

Communicate the Phenomenon

What Students Are Doing

In this section, students will participate in an R.A.F.T. exercise to communicate what they have learned about water systems. They will focus on picking a role, audience, format, and topic. This activity is a great opportunity for students to use their creativity and show what they have learned in this lesson.

Teacher Guidance

6. This activity can be used as an assessment tool, a culminating activity, or an extension. Hand out student R.A.F.T. worksheets and encourage students to pick an item from each category. This can be done in class or as a homework assignment. Here is the worksheet that can also be found in teacher materials:

Pick one from each column to "choose your own adventure" related to our Water System

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Role	Audience	Format	Topic
Science Teacher	Student	Poster	Chemical contamination
Newscaster	Viewer	30-second video	Microbe contamination
Politician	Voter	250 character tweet	Microplastics
Hydrologist	Worker	Slide Show	Filtration
Salesman	Consumer	500-word paper	Water treatment system
Older Sibling	Younger Sibling	Poem	Access to clean water

For example, create a 30-second video as a salesman addressing consumers and explaining a filtration system.

Whatever you choose, please ensure your adventure addresses our water system, concerns with water pollution, and a call to action.

Listen for:

Ideally, if students work in partnership instead of large groups, the conversation and questions asked and answered will be of higher quality.

- An accurate understanding of water systems
- Pros and Cons of different methods
- Constraints that restrict successful systems to flourish
- Actual science being used in the purification process
- Students relating concepts to real-life experiences
- Creativity and new ideas being explored
- Solutions to problems locally and afar

This lesson was created by Jami Slack, Matthew Cottrell, & Carly Yeates

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