Culturally Responsive STEM Lesson Plan:

NATIONAL MAGLAB
Research Experiences FOR TEACHERS

Oil Clean-Up

Lesson Objectives:

- SWBAT articulate how water can be used by people, plants, and animals.
- SWBAT describe the possible consequences of pollution on humans or nature.
- SWBAT use evidence to support a claim about the effectiveness of different oil spill clean-up methods.
- SWBAT analyze and discuss data around the effectiveness of various clean up techniques

Next Generation Science Standard:

- Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. 5-ESS3-1

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
- Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. 4-ESS3-2

- Construct an argument with evidence, data, and/or a model. (3-LS2-1)
- Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS4-1)
- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-LS4-4)

- Develop a model to represent the shapes and kinds of land and bodies of water in an area. 2-ESS2-2
- Obtain information to identify where water is found on Earth and that it can be solid or liquid. 2-ESS2-3
- Make observations of plants and animals to compare the diversity of life in different habitats. 2-LS4-1
- Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2)
- Make observations (firsthand or from media) to collect data which can be used to make comparisons. (2-LS4-1)

STEM Rationale for Lesson:

Water is an integral part of human life, as well as the lives of the plants and animals around us. Water has ties to chemistry, biology, Earth processes like weathering and the water cycle, physics concepts like states of matter and fluid properties. Water pollution in particular can be connected to ecosystems and human processes and is also easily connected to real-world applications. Oil spills like the Exxon-Valdez spill in 1989 and the Deepwater Horizon spill in

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2010 are real-world events that required a great deal of STEM knowledge and the use of the engineering process by scientists and engineers.

Outside of the general concepts discussed, this lesson plan outlines a method for students to make predictions, conduct an experiment, collect and analyze data, and make claims that are supported with evidence – all necessary parts of the STEM process.

Culturally responsive connection:

Every student – every human! – has experience with water. We use water to drink, to wash ourselves and our belongings, to grow our food, to have fun with, and other purposes. Every student can come into class and make a personal connection to a discussion of water. This is especially true in Minnesota, the land of ten thousand lakes and the great Mississippi River. Water, and its abundance, is an essential part of the dominant culture of Minnesota. For students who may come from places where water sources look very different, or where there has been drought, can still make connections to the importance of water AND provide a unique perspective around the importance of protecting water.

Specific to Minnesota, there has also been a recent economic and political push for ill-regulated pipelines to transport oil between Canada and the rest of the United States. These pipelines have been widely publicized, in no small part because of the massive public backlash they have faced. In particular, some of these pipelines threaten to illegally travel through sovereign indigenous nations and spill thousands of gallons of crude oil into essential water sources. This is something that every student can be introduced to and given background information on through the book *We Are Water Protectors* by Carole Lindstrom.

The lesson will be introduced with a discussion on the various uses of water, where students will be able to contribute their own experiences as well as learn about unfamiliar experiences that their classmates have had. Students can also optionally explore water from local sources, investigating living macroinvertebrates in their natural habitat.

Materials Needed:

Provided by Teacher:

We are Water Protectors by Carole Lindstrom

The Feather Atlas - Feather Identification and Scans - U.S. Fish and Wildlife Service Forensics Laboratory (fws.gov)

Part 1

Assuming groups of 4 students, each group will need:

- 1 large container for the “mini-lake,” e.g., a pie tin, baking tin, or plastic bin
- water
- oil
- 4 plastic spoons
- cotton balls (or other absorbent material, e.g., sponges, paper towels, cloth pads)

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- dish detergent
- 1 cup to hold the removed oil & water
- 1 graduated cylinder (large enough to fit the oil & water removed from the mini-lake)
- funnel
- 1 waste container
- note-taking materials
- *optional: food coloring for the water in the "mini-lakes"*
- *optional: cocoa powder to color the oil*

Part 2
Assuming groups of 4 students, each group will need:

- 4 containers large enough to submerge a feather in, e.g., bowls or cups
- 4 bird feathers (stiff flight feathers, rather than fluffy down feathers)
- cold water
- hot water
- dish soap
- absorbent materials like paper towels, sponges, etc.
- oil
- *optional: cocoa powder to color the oil*

Activate Prior Knowledge (What prior knowledge should students have for this lesson?):

1. Water has a variety of uses
2. Animals have many structures with functions that help them survive
3. All living things need certain things (food, water, space, etc.) to survive

Lesson Introduction:

1. Students create a mind map to describe the many ways that humans use water. Depending on their history, they may be able to connect back to previous lessons, and/or may come up with unique uses from their own personal backgrounds.

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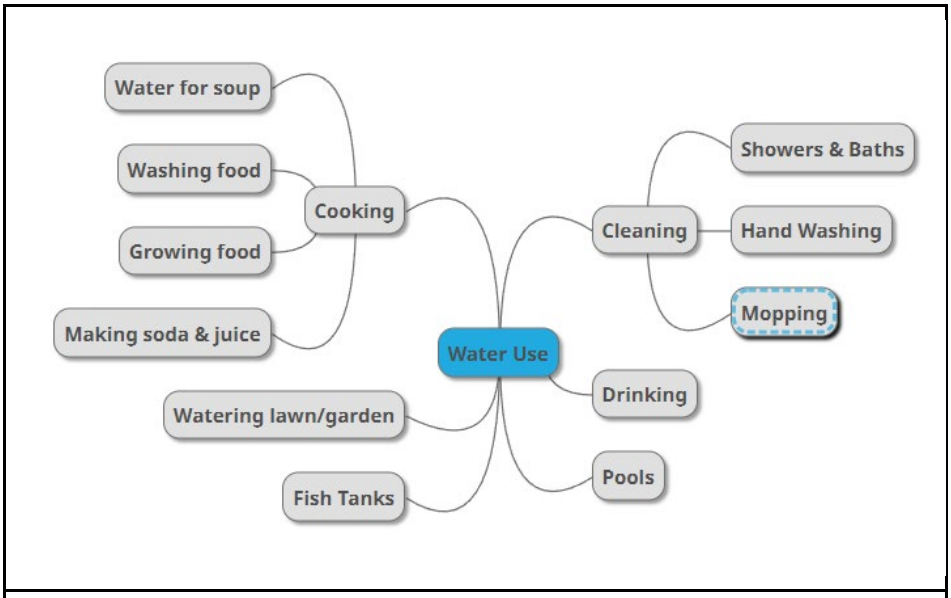

Example of a mind map representing human water use.

2. Plants and animals need water too! Students will watch videos of animals and plants that live around the Mississippi, with a focus on the birds that call it home.
3. **Extension:** Students can investigate the micro-habitats of macroinvertebrates by looking at cloudy pond water through a microscope OR through one of many online videos of macroinvertebrates.

Lesson Activity:

Part 1

1. Students will read *We Are Water Protectors* by Carole Lindeman as an introduction to oil pipelines and their relationship to local waterways.
2. Students will brainstorm what would happen if our water was no longer drinkable.
    a. What would humans have to do?
    b. What would happen to the animals?
    c. What would happen to the plants?
    d. **Extension:** students can investigate “mystery water” (full of random “pollutants”). Where do students think those pollutants come from? What do students think those pollutants are?
        - Students will use sand, etc to make a basic filter for particulates
        - But what about other kinds of pollutants?
        - **Extension:** use lemon juice, baking soda, etc, and demonstrate with pH indicators that some pollutants are invisible

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3. In small groups, students will start with a “mini-lake” of water in a large container or pan. Then, add vegetable oil to the pan. Their challenge is to remove as much oil (and as little water) as possible from the mini-lake.
4. Introduce a container for them to put the oil in, as well as their tools for oil removal: spoons, cotton balls/paper towels/etc., and any other tools you would like them to use. Have students predict what tool will work the best before the activity begins.
5. Start with the spoons. You may want to show them how to “skim” the oil off the top or see what they come up with on their own! Set a timer for 5 minutes and let students move oil from the mini-lake to the collection cup with the spoons.
6. Measure the amount of oil by pouring the contents of the collection cup into a graduated cylinder and waiting for the water and oil to separate (this may take some time; in which case you can move on to the next step). Students will have to use math skills to subtract the volume of water from the total volume, since the oil will float on the water. Have students record their oil volume.
7. Next, students can try the absorbent material. Make sure you add more oil to the mini-lakes, then start another 5-minute timer and proceed as before.
8. To measure the oil and water removed, students will need to squeeze out their materials into the collection cup. This can occur in between each dip or at the very end, whichever is easier.
9. Once again, measure the volume of oil removed in a graduated cylinder.
10. Finally, introduce the dish soap. What happens when you add dish soap to the oily mini-lakes (make sure it is mixed or stirred around for maximum effect)? What effect would this have on the organisms in and around the lakes? Will it make the oil easier or harder to remove?
11. Repeat the spoon and absorbent material trials with the dispersed oil.
12. Now each group should have 4 data points. Looking at the four numbers they collected, what was the most effective way to get rid of the oil? For any of the trials, was all the oil gone at the end?
13. **Extension**: add an extra challenge by adding an object to the mini-lakes to act as the land. Can students work fast enough to keep the oil away from the land?
14. **Extension:** Many methods of cleaning up oil spills involve accidentally capturing water organisms. You can simulate some of these issues by adding small objects like sprinkles to your mini-lake. How successful are students at removing the oil without the water OR the “organisms?”

Part 2

1. Review the birds that live in your local habitats, with a focus on water birds. What do water birds do to survive?

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   a. Possible answers: swim, fly, look for food, drink water, eat fish, eat plants, dive, etc.
2. Students will observe bird feathers from a variety of sources – in person, images from the US Feather Atlas, etc.
3. In pairs, students will use the feathers to flap air at each other's faces. Demonstrate and remind them not to poke each other in the eye!
4. Students will be asked to explain what function feathers serve. Possible answers include flying, flapping, moving, keeping warm, decoration, etc.
   a. **Extension**: Students can also investigate down coats, down pillows, down comforters, etc. This can be especially useful if you are unable to acquire stiffer flight feathers.
5. After the feathers have been fully investigated, students can dip SOME feathers in oil and observe. Do you think they can still do their job when soaked in oil?
6. **Optional:** students can make a prediction – what treatment will clean the feather best? Why do they think so?
7. Students can choose or be randomly assigned how they'd like to attempt to clean their feathers: dipping in cold water, dipping in hot water, dipping in soapy water, and wiping off with absorbent material.
8. **Data Connection**: survey students to find out a) their feather treatment and b) whether they were able to remove the oil from their feather. This data can be used to make a variety of graphs for students to practice interpreting.

Lesson Assessment

1. Grades 3-4: Students will write a claim with reasoning and evidence that answers the following question(s):
   - How does an oil spill affect organisms like birds?
   - What is the best way to clean up an oil spill?
2. Grades 1-2: Students will draw a picture or write what they think would have happened if the characters in *We are Water Protectors* were not successful in stopping the oil pipeline. Students will draw a picture or write what the best way to clean up spilled oil is.

Sources:

Students will write a claim with reasoning and evidence that answers the question(s):
We Are Water Protectors - American Independence Museum
Who Polluted the Charles River & Water Filtration – Center for STEM Education (northeastern.edu)
Find the Best Way to Clean Oil off Bird Feathers | response.restoration.noaa.gov
Small-Scale Modeling of Oil Spill Cleanup Methods - Activity - TeachEngineering

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