DEQ in the Classroom:

Pollution and a Healthy Environment: Like Oil and Water

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Grade Level:

4 – 8

The Questions for Discussion are divided into two parts. Part A deals with pollution and is appropriate for all participants. Part B deals with the properties of the mixtures and the corresponding vocabulary. This part is most appropriate for older or more advanced students.

Time Required:

30 minutes (+/- depending on level of discussion)

Objective:

To demonstrate how water becomes polluted and the difficulty of "cleaning" it once it does by observing how different types of pollutants mix with water, the properties of the resulting mixtures, and how these properties relate to water pollution, water quality, and water treatment.

Meets State Standards:

Grade 4: 4.S.2.1.2, 4.H.1.1.10
Grade 5: 5.SS.3.1.2, 5.SS.2.2.1, 5.S.2.1.1, 5.S.5.1.1
Grade 6: 6-9.GWH.2.5.6, 6.S.2.1.1, 6.S.5.1.1
Grade 7: 6-9.GWH.2.5.6, 7.LA.6.2.1
Grade 8: 6-9.GWH.2.5.6

Focus:

Water (surface/ground/drinking/waste), water pollution, water treatment. Students will pollute clean water and view the properties of different types of water mixtures. They will discuss how water can become polluted, how the properties of the contaminant can affect the ability to clean the water, and how they can prevent water pollution.

Materials: (for one experiment)

Water (15 cups)
Colored liquid dish soap (about 1 tablespoon)
Dirt or sand (1/2 cup)
Measuring Cups (1/4 cup, 1/2 cup, 1 cup)
Sharpie-type pen
Cooking oil (2 cups)
Sugar (1/4 cup or less)
Funnel
Large bowl to hold water (if no sink)
Labels to identify mixtures
5, 2-liter soda bottles with lids (clean and dry with labels removed; use clear not green)

Background:

Many things can pollute water: chemicals (e.g., motor oil), nutrients (e.g., phosphate in fertilizer), and sediment (e.g., dirt). Some of these mix completely with water; others are carried by water, but do not actually mix. The type of resulting mixture can affect whether the pollutant can be seen, how the pollutant is transported, how it affects water quality, and how/if the pollutant can be removed from the water (remediated).

Vocabulary:

Contaminant	Something that makes something else unclean (e.g., mold on your food).
Drinking Water	Water that is used for drinking and other household functions.
Ground Water	Water beneath the earth's surface.
Homogenous	The same throughout.
Immiscible	Two liquids not capable of mixing or remaining mixed (e.g., oil and water; Italian salad dressing).
Miscible	Two liquids capable of mixing and remaining mixed (e.g., food coloring and water). A type of solution.
Mixture	Two things (liquid, solid, or gas) that have been combined. A mixture may or may not form a solution.
Nonpoint Source Pollution	Pollution originating over a wide geographical area; not discharged from a specific location or "point." Nonpoint sources of pollution include roads, agricultural fields, logging, and mining.
Point Source Pollution	Pollution originating from a specific "point" of discharge, such as a pipe or ditch. Point sources of pollution include factories, aquaculture facilities ("fish farms"), and wastewater treatment plants.
Pollution	Something that contaminates (hurts, makes dirty) the natural environment; usually a result of human activities.
Remediate	To correct a fault or deficiency; to remove contaminants from the environment.
Sediment	Fine materials from weathered rocks and organic material that are suspended in, transported by, and eventually deposited by water or air.
Solution	A homogenous mixture of two or more substances. Once mixed, the individual substances can no longer be identified (e.g., Kool-Aid® dissolved in water).
Surface Tension	The tendency of liquids to reduce their exposed surface to the smallest possible area. This tension makes the surface of the liquid act like it was made of very thin elastic. It is what causes water to form individual droplets and allows some small insects to "skate" across the surface of water. Water has a high surface tension; alcohol has a low surface tension.
Surface Water	Bodies of water, such as streams, lakes, rivers, and wetlands, which are on the surface of the land.
Surfactant	A substance capable of reducing the surface tension of a liquid in which it is dissolved. Soap is a surfactant.
Suspension (Suspend)	When solid substances mix with water, but do not dissolve (they are insoluble), they are "suspended." Eventually, the particles separate themselves from the water (e.g., sink to the bottom, like sand, or float to the top, like sawdust) and are no longer suspended.
Wastewater	Used water, such as from a home, that contains enough harmful material to damage the water's quality. Every building with running water generates some sort of wastewater.

Procedure:

As described here, this activity is designed to be done jointly as a class. However, the solutions can also be made individually or in small groups.

Step 1. Ask students why water is important. How do we use it? Why should we care about water and whether it is clean? *Possible answers: need it for drinking, watering plants, bathing, swimming, for fish and other things that live in it, to support a healthy environment in general.*

Step 2. Ask students to think of pollutants that could get into water. Write their list on the board. *Possible answers: motor oil, soap, sand/dirt/sediment, pop (soda), litter/trash, dog/cat/horse/cow/ human poop/pee, gasoline, medicines (flushed down the toilet), fertilizers, pesticides*

Step 3. Label the tops of the soda lids 1 through 5 and place a paper label in front of each bottle (not attached) labeled "1," "2," "3," "4," and "5." *(Suggestion: pre-label the other side of the pieces of paper with the labels for Discussion Question 1 [Part A] or 7, 8, and 9 [Part B]).*

Step 4. Pour 3 cups of water into each 2-liter bottle.

Step 5. Add 1 cup of cooking oil to bottle #1. Replace the lid. (Don't shake!) *Point out to students that the cooking oil represents many types of oily pollutants. Ask them to name some (e.g., motor oil).*

Step 6. Add 1 squirt of dish soap to bottle #2. Replace the lid. (Don't shake!) *Ask students how soap could get into water in the environment (e.g., washes down storm drain after washing car, campers throwing out their wash water).*

Step 7. Add 1 cup of cooking oil *and* 1 squirt of dish soap to bottle #3. Replace the lid. (Don't shake!)

Step 8. Add ¼ cup of sugar to bottle #4. Replace the lid. (Don't shake!) *Ask students what they think will happen to the sugar. Once they tell you "dissolve," ask what other solids dissolve in water (e.g., salt, fertilizer granules, aspirin).*

Step 9. Add ½ cup of dirt/sand to bottle #5. Replace the lid. (Don't shake!) *Point out to students that while sediment (dirt) is natural in water, unnaturally high amounts are bad. Ask how lots of sediment could get into water (e.g., erosion, dirt roads, land slides).*

Step 10. Have each student record what they see in each bottle. *Continue to use bottle numbers to identify bottles; they will be labeled with the substances during the discussion.*

Step 11. Shake each bottle for 15 seconds (students can do this). Shake <u>bottle #4 (sugar) vigorously</u>. Shake <u>bottles 2 and 3 (those with soap) *very* gently</u> (teacher may want to do this) or there will be too many suds to observe effects. Have students observe and record what happens in each bottle.

Step 12. Hold up each bottle (be careful not to disturb the mixtures; you want them to settle) **and ask if anyone would like to drink what's in it** (don't actually let them). When they say "yes," ask why. Discuss the answers. After someone says "yes" to the sugar bottle, point out that it would look exactly the same if it was fertilizer dissolved in it instead of sugar. Do they <u>*really*</u> know you used sugar?

Step 13. After recording observations and discussing drinking, **have students look again and observe and record any differences** they see after the solutions have settled for a few minutes.

Questions for Discussion, Part A (everyone):

For older/advanced students, discuss Part B questions first, then discuss Part A questions, beginning with Question 2.

1. **What did you observe as and immediately after you shook the bottles? What about after they settled? Can you tell by looking which bottles contain which substances?** *As they identify the bottles, place a label in front of each (e.g., "oil," "oil/soap") to facilitate the rest of the discussion.*

2. **You've seen that different things act differently when mixed with water: some dissolve, some sink, some don't mix at all. Would this matter in water pollution? Would some types of pollutants be harder to detect? Harder to clean? Can you tell water is polluted just by looking at it?**
   Possible answers: Can't see some pollutants (dissolve in water), so must test for them – harder to detect. Water may be polluted even if it looks clean. Things that dissolve in water (like sugar) can be harder to clean/separate than some other mixtures, but all can be difficult to clean. Things that are suspended in water (e.g., sand/sediment) could be cleaned with filters.

3. **Adding soap to the oil/water mixture changed the properties of the oil and made it more readily mix with water. Different pollutants mix in water in real life all the time.** *For instance, one stream may have sediment (dirt) from erosion, motor oil that someone spilled, excess fertilizer from yards, soap from washing cars (all called "nonpoint" sources because they aren't from one specific place), plus pollutants from industry (called "point" sources because from one specific place).* **How could this affect water quality?**
   Possible answers: Pollutants can interact (like the soap and oil), which can make them more or less harmful to the environment, more or less easy to detect, or more or less easy to clean.

4. **Look at the list of pollutants you created as we began this activity. Are there others you want to add? What are some ways these types of pollutants (and others) could get into surface, ground, drinking, or wastewater?**
   Some possible answers: poured on the ground (intentional), spilled on the ground (accidental), dumped down storm drains, flushed down the toilet, poured into a lake or river, erosion, left on the ground (dog poop/litter).

5. **What can we do to help?**
   Some possible answers: Don't let the pollutants get into water in the first place, don't pour anything down a storm drain, make sure Mom and Dad use the correct amount of fertilizer so extra doesn't wash away, don't litter, pick up other people's litter, pick up after your pet, be careful what chemicals (medicine/cleaners, etc.) you pour down your sink/toilet, don't pour chemicals (even pop) on the ground.

Questions for Discussion, Part B (older/advanced students):

For older/advanced students, discuss Part B questions first, then discuss Part A questions, beginning with Question 2.

Suggestion: Have the definitions of "mixture," "miscible," "solution," "immiscible," and "suspended" written on the board ahead of time, then discuss the meanings of these words and the differences among the different types of mixtures before continuing with the following questions. Leave the words with the definitions on the board to help with the answers.

6. **What did you observe as and immediately after you shook the bottles? What about after they settled?**

7. **Which of the bottles contain solutions? (Use vocabulary list) How could you tell?**
   Solutions = bottles 2 and 4 (dish soap and sugar). The others didn't become homogenous substances, so aren't solutions (you can still see the oil and sand). Point out that bottle 2 is called a "miscible" solution because it is made of two liquids. As the students answer correctly, place a label in front of each bottle to identify the mixture and the appropriate terms ("dish soap/solution/miscible" and "sugar/solution").

8. **Which of the bottles contain immiscible mixtures? (Use vocabulary list) How could you tell?**
   Immiscible = bottles 1 and 3 (oil and oil/soap). The oil and water do not mix to become homogenous (you can still see both liquids). The soap is a "surfactant" and helps the oil to mix with the water (this is why dish soap helps with greasy dishes), but the oil still doesn't mix completely. Immiscible refers only to mixes of liquids. As the students answer correctly, place a label in front of each bottle to identify the mixture and the appropriate terms ("oil/immiscible" and "oil and soap/immiscible").

9. **Which of the bottles contain suspended mixtures? (Use vocabulary list) How could you tell?**
   Suspended = bottle 5 (sand). The sand and water do not mix to become homogenous (the sand is suspended in the water and eventually sinks). Suspended refers to mixtures of liquids and solids. As the students answer correctly, place a label in front of the bottle to identify the mixture and the appropriate term ("sand/suspended").

10. **Refer to the list of pollutants you made before beginning the exercise. What types of mixtures would those pollutants make when mixed with water?** *(Suggestion: if room, put the list of pollutants from the beginning on the same board as the definitions of the types of mixtures and draw lines between as students identify them.)*

    Answers to some potential items on the list include:

Oil based paint	Immiscible. Doesn't mix with water.
Sediment	Suspended. Doesn't dissolve; carried by water/may eventually sink.
Fertilizer granules	Solution. Mixes (dissolves) completely in water.
Soda	Miscible. Mixes completely with water.
Candy bar wrapper	Suspended. Doesn't dissolve; carried by water/may eventually sink.
Motor oil	Immiscible. Doesn't mix with water.
Poop	Suspended. Doesn't dissolve; carried by water/may eventually sink. (although it would partially decompose and some of the nutrients would become a solution)

Assessment/Follow-Up Suggestions:

Before the Activity:

- Teacher brings in one water sample from a nearby lake or creek. Have students look at the sample and see if they can identify anything in it that looks like pollution. Can students identify what the pollution is? Would there be any pollution in the water they can't see? Discuss how the pollution might have gotten into the water (where it came from). Point out that water naturally has lots of "stuff" in it, such as plants, insects, some sediment, etc. Even drinking water isn't just water. It contains minerals (amounts and types vary by water supply) that affect the taste of the water and sometimes added chlorine (to keep the water clean) and fluoride (for healthy teeth).

After the Activity:

- Complete "Questions for Discussion," above.
- Re-look at the same water from "Before the Activity." Discuss again. Does what you've learned changed any answers/discussion?
- Have each student bring in a sample of water in a jar and have them record where it came from (e.g., home with private well, home with city water, Big Creek, Snow Lake, etc.). Look at the samples and have students compare and contrast what they see. Can they identify pollution? What samples are most polluted? Least polluted? Why? What pollutants might be there that they can't see? **OR** Have each student collect three or four samples and compare/contrast individually and report to the class.
- Research a pollutant and prepare an oral or written report on it (e.g., motor oil, sediment, fertilizer, dog poop, soap from car washing, etc.). Explain how it gets into water and what can do done to keep it out.
- Create a poster encouraging others to keep pollutants out of the water and showing them the correct way to dispose/deal with pollutants.
- Tour your local wastewater treatment plant.
- Research how water is protected in your area. Who is in charge of making sure the water is clean? Do residents have any responsibilities? Prepare an oral or written report. A good place to start is DEQ's Web site at www.deq.idaho.gov. Also check with your city or county.
- Include vocabulary in spelling lists (if completed Part B of Questions for Discussion).
- Test on definitions of vocabulary (if completed Part B of Questions for Discussion).

Additional Resources:

Common Measures of Water Quality (DEQ Web site)
http://www.deq.idaho.gov/water/data_reports/surface_water/monitoring/standards.cfm#some

DEQ Kids: Water Does A Lot For Us . . . What Can We Do For Water? (DEQ Brochure, June 2005: pdf 323 kb, 2 pages) http://www.deq.idaho.gov/water/educ_tools/water_quality_kids_brochure.pdf

DEQ Kids: Water Quality in Idaho (DEQ Fact Sheet, March 2002: pdf 30 kb, 3 pages)
http://www.deq.idaho.gov/water/educ_tools/water_kids_tips_fs.pdf

Drinking Water Protection (DEQ Web site)
http://www.deq.idaho.gov/water/prog_issues/source_water/protection.cfm

Ground Water in Idaho: Monitoring and Protection (DEQ Web site)
http://www.deq.idaho.gov/water/data_reports/ground_water/monitoring/overview.cfm

Irascible Immiscible Liquids (San Carlos Charter Learning Center Web site)
http://www.kn.sbc.com/wired/fil/pages/listimmiscibim.html

Mixtures: Solutions, suspensions + miscible and immiscible liquids (Loreto College Coleraine Science Department Web site) http://www.lcc.ukf.net/KS3Chem/mixtures.htm

Nonpoint Source Management (DEQ Web site)
http://www.deq.idaho.gov/water/prog_issues/surface_water/nonpoint.cfm

Surface Water: Monitoring and Assessment (DEQ Web site)
http://www.deq.idaho.gov/water/data_reports/surface_water/monitoring/overview.cfm

Water Quality: Educational Tools (DEQ Web site)
http://www.deq.idaho.gov/water/educ_tools.cfm