Educators' Guide: One Drop

Water is an essential building block of all life. It covers our planet, but very little is available to be shared among people and ecosystems. Healthy water is required for a healthy planet. These lessons build upon the *Water/Ways* and *We Are Water MN* exhibits. Components of the exhibit focus on water quantity, water quality, and water equity. These lessons can also be used as stand-alone activities for learning about cultural connections to water, watersheds, and impacts of land and water use on water quality.

The activities in these lessons will demonstrate the amount of the earth that is covered in water, that water is a shared resource, that people manage and share water in different ways, and how the scientific method can be used to learn about water (quality) issues.

Objectives:
Students will be able to:

1. Discuss how water is a limited resource and factors that affect its availability
2. Role-play and then describe how water is a shared, managed resource
3. List two types of pollution (point source and non-point source pollution) and discuss how pollution can adversely affect water quality
4. Develop a pollution investigation using scientific method

Subjects: Science, Language Arts, Reading

Time Required: 45 minutes for individual activities—multiple class periods

Grade Level: Upper elementary through middle school; younger and older with modest modifications

Materials: Inflatable globe (like a beach ball), 1-2 decks of cards (or game pieces), supplies for completing student investigations into pollution (students develop materials list)

Background:
Water is amazing. It covers the planet and can take the form of a solid, liquid, or gas in the same environment! But this resource is shared and finite. The hydrologic cycle, or water cycle, moves water around the planet. Building strong relationships, communication, and planning are all critical components to sustaining water.

The scientific method is a way to ask and answer scientific questions by making observations and doing experiments. Students will learn more about pollution by creating an investigation using the steps of the scientific method: ask a question; do background research; construct a hypothesis; test your hypothesis with an experiment or investigation; analyze your data; draw a conclusion; and communicate results.

Procedures/Activities:

All the World: How Much of Our Planet Is Covered By Water?
Have students stand in a circle. Tell the students that they are going to combine a game of catch with math to determine how much of the earth is covered in water. Allow students to gently toss the globe to one another. Each student will count the number of fingers touching blue (water)—remind them not to move their fingers once they catch the globe. Record each student's number as the globe is tossed around the circle. Determine the average of these numbers and turn it into a percent by multiplying by ten. If the average number is 7, the percentage becomes 70% and 7.3 becomes 73%.

Once students have a greater understanding of the amount of earth covered by water, inform them that **oceans** hold 96.5% of the entire planet's water. Ask students to think about where the remaining 3.5% of the water exists naturally. Remind students that right now we don't need to think about man-made infrastructure like swimming pools, toilets, or water towers. Students frequently remember **lakes** and **rivers**. Provide assistance by asking students to think about the other states or ways water can exist. **Glaciers** are made of water that is ice (or a solid) and **clouds** are made of water vapor (or a gas). Water is also found in our **bodies** (animals) and **plants**, in the **soil** and underground in **aquifers** (groundwater).

Extension:
Ask students to think about the many different people living on the earth. Different cultures have different ideas and values about water. These people and all animals and organisms need water to survive. As students are guided through these activities, encourage them to think about how their decisions about water affect other people and things.

Three Point Five Percent: Fresh Water
Present students with a math problem. Tell them it's going to be one of the hardest math problems they will ever be presented.

If 96.5% of all the earth's water is in the ocean (saltwater), what is the percentage of water found in the other locations? Of course 3.5% is an easy answer. However, much of the 3.5% is not available for human use because it is frozen in glaciers or deeply underground. Realistically, less than .01% (one hundredth of one percent) is *readily* available for human use. It's also approximately the same amount that is also readily available to animals, plants, and ecosystems that depend on fresh water.

So while it sometimes seems like water is in abundance, there are many constraints on that water. Ask students to think about and share some of those constraints before moving on to the other parts of this lesson. Their list of constraints may include:

- The amount of water that is available for use is a very small portion of all the earth's water
- Water isn't always plentiful in the places it is needed
- Water may not be clean enough to drink or use/water may be dirty
- The way we move water around (infrastructure) may not be good enough
- While water moves around because of the water cycle, no new water is created

Mine or Ours: Learning About a Limited Resource That Must Be Shared
Have students sit together in groups of four. Place 16 cards in the center of each group (you can also use game tokens, pennies, gum, or pieces of candy). Share the following:

1. Each person may take as many cards as they want when it is their turn
2. They must take at least one card; you will need at least one card per round to "survive"
3. The cards symbolize available water; the cards in the center are the (shared) water supply
4. Because of the water cycle, the water will be replenished between rounds

After the first round, ask if there are groups that have nothing left in the center. Ask students to think about what will happen to them without access to water. Ask students if they are the only things that need water. What else needs water? What will happen to the animals, plants, and other people that need that water to survive?

After the first round, replenish each group's cards—give them half the number that is still in the center. (For example, if there are 12 cards left in the center; give the group an additional 6 cards.) For this round only, have any groups that ran out of cards place all 16 of their cards back in the center and try again. Inform students that in future rounds, if there is no water left, none will be replenished.

After each round, continue to replenish each group's cards with half the number that is left. Play several more rounds. Between each round, determine if there are any students who ran out of water or any teams that depleted their water source. Provide each group with their new cards between each round.

After several rounds, have students discuss what happened in their groups. Are there any groups that have more water than when they started? How were they able to sustain their water use? Why did they choose to sustain their water use? For additional discussion, consider these questions:

- Were there any students that took more than one card per round?
- If they only need one card per round, why did they take more? (This could symbolize using water to make money or using water luxuriously.)
- What was the role of communication?
- Did the group make rules? What were they?
- What was your goal as a group? What were you working toward or trying to figure out?

Tell students that one of the goals of the activity is to work towards sustainability, meeting your needs without compromising others or the planet (present and future).

Share with students that while the amount of water available on the earth is finite, or limited, the water cycle moves water round and replenishes it (in some areas). Water (as a liquid) fills oceans, lakes, and rivers. It evaporates, or changes from a liquid to a gas, and rises into the air where it becomes clouds. Water returns to earth as precipitation: rain, snow, and sleet. Snow and sleet are water as a solid. This precipitation lands on the earth and flows back into the oceans, lakes, and rivers. In this way, water acts like a renewable resource that must be managed and shared carefully.

Extension:
Reflect on the **Mine or Ours** experience with the students. How did they feel if they ran out of water? What would happen if they were a country or a group of people and had run out of water? Ask students to share the factors that led to their success in sustaining their water supply. These factors will most likely include:

- Communication (talking to one another)
- Agreeing to work together / realizing that they needed to work together to have enough water
- Friendships
- Trust

Most of the factors that students provide are important parts of establishing and keeping relationships with the other members of the group.

Play another round of the activity with the students. This time, provide each member of the group with a written instruction that they aren't to share with anyone else in their group. Three of the instruction pages should say, "*Take* just one card and leave the rest for the group to share." One of the instruction pages should say, "*Take all remaining cards for you*."

After each group has one person who takes all the cards (all the available water), ask the students how they felt when that person took all the cards (or water). How did that person changing the agreement to sustain water affect the relationship? Ask students to think about ways that they could ensure or guarantee that all members of the group sustained the water.

Since water is a shared resource and it crosses borders, countries, states, communities, and individuals will often look for ways to agree on water use to control quantity and quality. These are commonly referred to as water compacts. Governmental entities will also create water laws to control water use. For additional research opportunities, students can research water compacts or laws that apply to their community. Suggested questions to assist in research and discussion include:

- How are you affected by these water laws? Do you feel this is positive or negative?
- How is your community affected? Do you feel this is positive or negative?
- Are there groups that benefit more than other groups from certain water laws? Are there groups that are at a disadvantage because of certain water laws?
- Did your research find additional information from the point of view of someone who benefits or is disadvantaged from current (or past) water laws?
- Do you see ways to make water laws and regulations more equitable?

Extension:
Introduce the concept of clean water and pollution to the activity. Mark four cards (or game pieces) per group with an "X" to symbolize polluted water. Explain that students will "survive" with one pollution card, but they will be out of the game with two.

You can also include one or two cards per group marked with a circle. This card symbolizes the ability to clean the water pollution. If a player gets that card, they can exchange any pollution cards for clean cards but then must discard the pollution cleaning card. Ask students to think about how pollution affects the ability to use water.

A Glass of Water, Hold the Salt: Using Scientific Method to Investigate Pollution
Remind students that they have spent time learning about water as a shared resource. The work they were doing assumed that all the water that was available to them was "clean" and unpolluted. However, many human activities cause pollutants or harmful substances to enter our waters. It won't matter how much water is available if it's polluted.

As a class, create a definition for pollution. Essentially, it is contaminants in the environment that can cause negative changes or have a negative effect. The harmful impact might be on human health, ecosystems, or other things we want to protect like water safe for swimming or water that sustains wild rice plants. Some pollutants are harmful at very low levels and some are only harmful when the levels get really high. Scientists are always trying to determine how much of a pollutant it takes to cause a negative change.

Introduce (or review) the terms point source pollution and non-point source pollution. Point source pollution is any single and identifiable source for the introduction of pollutants into an environment. Pipes, smokestacks, and leaking tanks are types of point sources.

Non-point source pollution is when pollutants enter the environment from multiple sources over a large area instead of a single source. Non-point source pollution is considered one of the greatest threats to water quality. Water from rainfall or snowmelt moves over and through the ground moving pollutants into lakes, rivers, wetlands, and other bodies of water.

Minnesotans use salt on sidewalks, driveways, and roads in an effort to reduce ice each winter. As snow melts and it rains, the salt is dissolved into the water. The salty water is absorbed into the ground (and plants) or moves with the water across the land's surface to local streams and lakes.
Tell students that they will be using scientific method to create an investigation to determine the effects of saltwater (or other pollutant) on an area. Remind students that they will use their questions and observations to reach a conclusion. (This activity can be done in small groups or as a class.)

First, **ask a question.** Depending on the age of the students or the level of study, the question may be simple or more complex. A single investigation may focus on the question, "What are the effects of saltwater on plants?" Multiple investigations may allow for the questions to focus on different possible pollutants. The question may get fine-tuned as the investigation is developed (for example, the kinds of plant will need to be selected).

Second, **develop a hypothesis**. Based on what they know, believe, or have researched, have students develop an, "I think…" statement. Students should create their own, but it could be similar to, "I think that saltwater will kill Plant A."

Next, **create and conduct your investigation**. Students will need to identify and gather the materials needed for their investigation and write out the procedures or steps. These may include where they will get the grass or how they will make their observations, the amount of salt or pollutant that will be added to the water, how that polluted water will be added to the grass, etc. Remind students of the importance of creating a fair test. This can occur when only one factor (or variable) changes in the investigation and everything else stays the same. What stays the same are the controls and what changes is the variable. There should only be one variable.

As part of creating their procedures, have students create a list of the things that they will not change in the investigation. The list with what will change should only have one thing on it for each investigation.
For this example, the control could be watering a plant with unpolluted water and making observations. The variable would be watering the same type of plant with saltwater. Students shouldn't introduce a second pollutant to the investigation.

Have students carry out the steps of the investigation and make observations. Based on their observations, have students make their **conclusions.** Conclusions are when students use their results to answer their question and prove (or disprove) their hypothesis. Students should share their results and determine if more investigations are necessary or if there was an error in their investigation. Students may find that additional investigations are needed to fully answer their question or results could be shared between groups. Additional questions that may arise with this example may include: How much saltwater affects the plant? Are all plants affected the same way by saltwater?

Once investigations are completed and information is shared, have students reflect on how what they learned will affect their own habits. How do scientists and people use the information they learn from investigations like the ones they conducted? How else could the scientific method be used to answer questions about water? Students can examine other research to see if their results are similar to others' and what else has been learned in their research topic. However, even with complex questions, investigations are set up to change only one thing (variable) at a time!

Remind students that no issue is black and white, and their investigations were limited in scope. Winter salting practices create safer walkways and roadways in our state. It's important to know the effects of our actions and how to balance what we know with what we do. In this example, students' questions and investigations may help them realize that they can take care of their sidewalks with less salt and have less of an impact on their green spaces and waterways.

Reflect
Have students reflect on the idea of water as a shared resource. How can the scientific method help them with their "water relationships?" How can it help their community? How could the students share the information they learned?

Extension:
The Minnesota Pollution Control Agency has a great deal of information on winter salting practices and water quality, as well as other non-point source concerns. They have educational and informational materials that students can use to share what they have learned about pollution. Visit www.pca.state.mn.us/roadsalt. Additional resources are available from the Minnesota Humanities Center at http://mnhum.org/waterways/resources.