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Grade and Topic: 3rd through 8th grades, Aquifer in a Cup activity

Length of Lesson: 45 – 50 minutes

**CENTRAL FOCUS**:

The purpose of this lesson is to build upon the knowledge students may already have about the water cycle and to further educate them on our local water source. In this lesson, students will learn about the Memphis aquifer, the source of their drinking water, and the effects of groundwater pollution through a hands-on activity. Each student will build an aquifer model in a cup to observe the water’s behavior before and after it is “contaminated” and punctured by a “well.” Discussion will take place before, during, and after the activity, which will introduce new vocabulary and encourage critical thinking. Students can use the information they learn in this lesson to teach their families and to make better choices regarding water conservation and pollution management.

**STANDARDS ADDRESSED:**

Third Grade

* 3.ESS2: Earth’s Systems: Explain the cycle of water on Earth.

Fourth Grade

* 4.ESS3: Earth and Human Activity: Create an argument, using evidence from research, that human activity (farming, mining, building) can affect the land and ocean in positive and/or negative ways.
* 4.ETS2: Explain how engineers have improved existing technologies to increase their benefits, to decrease known risks, and to meet societal demands (artificial limbs, seatbelts, cell phones).

Fifth Grade

* 5.PS2: Explain how forces can create patterns within a system (moving in one direction, shifting back and forth, or moving in cycles), and describe conditions that affect how fast or slowly these patterns occur.
* 5.ETS2: Describe how human beings have made tools and machines (X-ray cameras, microscopes, satellites, computers) to observe and do things that they could not otherwise sense or do at all, or as quickly or efficiently.

Sixth Grade

* 6.LS2: Research the ways in which an ecosystem has changed over time in response to changes in physical conditions, population balances, human interactions, and natural catastrophes.
* 6.ESS3: Assess the impacts of human activities on the biosphere including conservation, habitat management, species endangerment, and extinction.

**LESSON OBJECTIVE(S):**

* Students will identify the different layers of the Memphis aquifer
* Students will explain the significance of the Memphis aquifer
* Students will identify sources of water pollution
* Students will analyze the effects pollution has on our water sources

**MATERIALS:**

* Clear, flexible plastic cups
* White or gray modeling clay
* Playground sand
* Pea gravel
* Red food coloring
* Plastic straws (preferably thick, sturdy milkshake straws)
* Water pitcher with water
* Newspapers or craft paper
* Large trash can

**BACKGROUND:**

The city of Memphis has a steady supply of drinking water which is pumped out of the ground from the Memphis aquifer (groundwater). The aquifer is the source of our tap water and many industries rely on it to power their businesses. The two biggest threats to this source of water are over-pumping and contamination. Contamination is possible due to various pollutants that may find their way into holes that have formed in the protective clay layer. This lesson is meant to educate young community members about the source of their drinking water, how the Memphis aquifer is structured, and how to keep it safe from pollution.

Key vocabulary in this lesson includes: Aquifer, Groundwater, Surface water, Runoff, Storm water, Pollution, Contamination, Conservation, Infiltration

**PROCEDURES AND TIMELINE:**

Prior to the lesson, the teacher should cover work surfaces with some form of paper or covering to protect the tables and help with cleanup.

**Introduction**

* The instructor(s) will introduce themselves and then say “Today we are going to be creating our own aquifer in a cup. Does anyone know what an aquifer is?” Allow time for a few students to answer and then explain the definition of aquifer. Then, the instructor(s) could ask about where the water inside the aquifer comes from. This should lead to a short discussion on the water cycle. The point of this is to determine the students’ level of prior knowledge. (5 minutes)
* Next, the instructor(s) will give a brief description of the activity and will state the objectives the students are expected to achieve. (5 minutes)

**Procedures**

* Students will each receive a small cup that has a pre-determined amount of sand inside of it. The teacher will explain that this sand layer represents the Memphis aquifer and that it holds the groundwater that we rely on to supply our city with drinking water.
* Next, each student will be given a small piece of clay. They will be instructed to roll it in their hands and flatten it into a small pancake. Then, they will fold the clay “pancake” in half and place it into their cup so that half of the sand is covered. They press it against the inside of the cup to create a shelf and secure it to the cup. The instructor(s) will explain that the clay represents the clay layer that sits on top of the aquifer and acts as a “confining layer” that confines the water and keeps the water from passing through.
* Students will then observe their cups as the instructor(s) pour water onto the clay and then the sand. They can tilt the cup so that the water pours off the clay and onto and into the sand. They should notice that the water does not infiltrate the clay layer, but it does absorb easily into the sand. (5 minutes)
* During conversation about groundwater, the instructor(s) will pour water into each student's cup. As the water enters the cup, students should be told to observe where the water goes and how it looks. The instructor(s) may need to ask prompting questions for students to notice that the water is being absorbed by the sand but is also sitting around the sand grains in air pockets. Students will most likely notice air bubbles coming up as the water displaces the air around the grains of sand. (5 minutes)
* Then, the instructor(s) will explain that the next layer consists of gravel. Explain what the purpose of the gravel is and why it’s important. Then demonstrate how to pour the gravel by tilting the cup to make a slope. Students will then be given their own gravel to pour into their cups. After pouring the gravel, the students will have more water poured into their cup. They should share their observations about what happens to the water as it moves through the gravel. The instructor(s) should discuss with the students how the water flows differently around sand, clay, and gravel. Students should also notice how some of the water sits on the surface of the layers. (10 minutes)
* The instructor(s) will ask students to observe the quality of the water and how it is uncontaminated. Then, ask the students what the water might look like if it became polluted. Demonstrate the effects of pollution by putting one or two drops of red food coloring into the cup. Then the instructor will add a drop of food coloring or two to each student’s cup to pollute their surface water. While students are observing the pollution spreading into their surface water, lead a discussion on what kinds of pollution could contaminate surface water, such as car fluids, lawn chemicals, construction runoff, litter, etc. Ask students what other pollutants could harm our water resources. Ask if they see the contamination seeping from the surface water into the aquifer. (5 minutes)
* Students will be given a straw and the instructor(s) will explain that the straw represents water well. Wells are used by industries to power their plants and by utilities (explain) to provide us with drinking water. Students should stick their “well” into the gravel/sand portion of their cup where there is no clay. The instructor(s) should ask the students what happens when the “well” penetrates the aquifer. They should notice that the polluted water travels through the layers and infiltrates the aquifer. (2 minutes)
* Next, students will be instructed to insert their “well” into the aquifer through the clay layer. The instructor(s) will explain that this is how we obtain water from the aquifer to use in our city. Ask students if the pollution can still spread to the aquifer water underneath the clay layer. The answer is that it can, because water will follow gravity, moving horizontally as well as vertically, which means that if a part of the aquifer that is not protected becomes contaminated, it has the potential to pollute the source. (2 minutes)

**Closure**

* The instructor(s) will ask lesson review questions such as
  + “Where does our drinking water come from?”
  + “What are the layers that make up the Memphis aquifer?”
  + “Why is water conservation important?” etc.
  + The instructor(s) may also review vocabulary.
  + When discussion ends, thank the students and teachers for participating. (5 minutes)
* Instruct students on how to clean their stations and assist in clean-up. Ask them to place the cups into the trash bins and not throw or drop them. (5 minutes)

Photo Examples of an Aquifer Model:

 