MeTEOR Learning Modules

STEM MEA (Model Eliciting Activity)

Understanding Water Pollutants

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METEOR
CONNECTING THE DOTS

Is the Water Contaminated?

Reflective Planning

Description/Summary of Lesson:
In this activity, students use models to investigate the process and consequences of water contamination on the land, groundwater and plants.

Essential Questions:
- What are pollutants?
- How do pollutants impact groundwater?
- What is the role of an engineer and the treatment of water?

Suggested Grade Level: Grades 3-5

Approximate Time:
- Day 1 (35-40 minutes)
- Days 2-7 (10 minutes for observation time)
- Day 7 (25 minutes for observations/questions/discussion)

Teacher's Role: Demonstrator and Facilitator

Class Set-Up: Groups of three-four students at tables or desks put together

Success Standards:
- Students will describe how polluted water contaminates the land, groundwater and plants.
- Students will understand how contaminants leach into the soil and ground water, and how plants absorb them.
- Students will describe how drinking water can be affected by pollutants.
- Students will understand the role of engineers in water treatment systems.

Learning Purpose:

- Students will describe how, when the environment changes, differences between individuals allow some plants and animals to survive and reproduce while others die or move to new locations.
- Students will make determinations proving that Earth is home to a great diversity of living things, but changes in the environment can affect their survival.
- Students will recognize and explain the need for repeated experimental trials.
- Students will recognize and explain that authentic scientific investigation frequently does not parallel the steps of "the scientific method."

Vocabulary:

- Groundwater
- Pollutants
- Contamination
- Water Table
- Environmental Changes
- Design
- Engineering

Math Practices:

- MP 1: Make sense of problems and persevere in solving them.
- MP 3: Construct viable arguments and critique the reasoning of others.

Depth of Knowledge:

- DOK Level 3: Strategic Thinking

Materials:

For demonstration (one time set-up/use):

- 1 Clear Jar (large mayonnaise or pickle jars with wide mouths work well)
- 1 Sponge (white or light-colored, thin, cut in half)
- Eyedropper
- Water
- Sand (enough to fill jar about 1/2 of the way)
- 2 Cups Gravel (enough for approximately a 1-inch layer)
- Red Food Coloring

For preparation of "contamination" (for all groups to share):

- 2-3 Gallons of Water
- ½ Cup Sugar

- ½ Cup Salt
- ¼ Cup Black Pepper
- 1 Cup White Vinegar
- 1 Cup Baking Soda
- 1/8 Cup Dish Soap
- 30 Plastic Cups or Beakers (medium-sized, transparent)

Each group should have:

- 2 White Carnations
- 2 Six-Inch Strips of Masking Tape
- 1 Index Card (to be used in advance by the teacher)
- Scissors
- 2 Different Colors of Food Coloring (groups may share)
- Teaspoon and Tablespoon Measuring Spoons (have several of each for groups to share)
- 2 Cups Water
- 3 Copies of Worksheets

Summary of Tasks/Experiences

Spark Activity: Begin with a class discussion asking questions.

- Have you ever poured your leftover soda pop onto the grass when you are done with it?
- How about soapy water after you have just washed a car?
- What happens to that soda or water? Does it just disappear?
- Have you ever taken a drink of water from a fountain or sink and thought it tasted bad?
- What did it taste like? What do you think made the water taste that way?

Lesson Descriptions:

Introduction:

- Provide background:
    - Most of the pollutants in water are ones that we cannot see. Sometimes, pollutants are microscopic bacteria that can make us sick, and other times, they are chemicals that are added to the water by water treatment plants to make us healthy (such as fluoride). Usually, we are told not to drink water from lakes or rivers because they might be polluted. What does that mean for the plants and animals that get their water from these lakes and rivers? Well, the

bacteria and bad pollutants can make animals sick or kill plants, and subsequently, if we eat the plants or animals, the bacterial may then travel into our bodies and make us sick. Imagine drinking water that tasted fine but was actually filled with contaminates that might build up in your body and make you sick after a few years. You might never know about it until it was too late to take preventative action. Fortunately, this rarely happens because environmental, civil and chemical engineers often participate in the water sampling and analysis process to ensure that your drinking water is safe.

- Engineers also work to protect the water that is under the ground where we live. This underground water is called the water table, and it exists almost everywhere. Sometimes the water table is close to the surface of the ground, and it makes the ground soggy; other times, it is farther below, and we never even know it is there. Engineers know how to protect and use this water table to help keep our drinking water safe.

- Tell the students that they are going to look at a demonstration that will show how pollutants on the ground can travel into our water supply through the water table.
- Next, they will look at what some of those pollutants can do to plants.
- In this activity, students will observe a demonstration of pollution entering a water table/aquifer.
- Student groups will then set up an experiment where they look at the effects of different contaminants on carnations in water versus a carnation in plain water as a comparison, or control variable. Prepare the large jar: fill it halfway full with sand in the bottom and small gravel on top of the sand.

Teacher set up:

- Prepare "contamination" instruction cards by writing each of the following individual "recipes" on an index card. Each student group will receive one contamination card:
- Mix 1 teaspoon of sugar into each of your cups.
- Mix 1 Tablespoon of sugar into each of your cups.
- Mix 3 Tablespoons of sugar into each of your cups.
- Mix 1 teaspoon of salt and 1 teaspoon of pepper into each of your cups.
- Mix 1 Tablespoon of salt and 2 teaspoons of pepper into each of your cups.
- Mix 3 Tablespoons of salt and 1 Tablespoon of pepper into each of your cups.
- Mix 1 teaspoon of baking soda into each of your cups.
- Mix 1 Tablespoon of baking soda into each of your cups.
- Mix 3 Tablespoons of baking soda into each of your cups.
- Mix 1 teaspoon of vinegar into each of your cups.

- Mix 1 Tablespoon of vinegar into each of your cups.
- Mix 3 Tablespoons of vinegar into each of your cups.
- Mix 1 drop of dish soap into each of your cups.
- Mix 5 drops of dish soap into each of your cups.
- (Note: Add cards for other suggestions of your own.)
- Prepare "contaminated" and plain water. Use food coloring to make about a gallon of darkly-dyed water for contaminated water and another gallon of different colored water for "plain" water. (Note: It is helpful to color the plain water solution as well, so students can observe that water is moving through the stem of the carnation.)

With the Students
Demonstration

- Distribute Observation Worksheets to each student.
- Pour some plain water into the sand/gravel-filled jar (until the water level fills about half the remaining space of the jar — at least a few inches above the gravel line). Ask students to identify the water table (the area below represents the aquifer). (You may want to color the water orange or yellow so that it is easier to see.)
- Place a dry sponge on top of the gravel in the jar to represent a landfill.
- With an eyedropper, carefully place five-six drops of food coloring on the sponge to represent the contamination in the landfill. Ask students to predict what will happen to the "contamination" (food coloring) if you pour the water (representing rain) onto the sponge.
- Slowly pour about one cup of water onto the sponge.
- Ask students to write down their observations of what happens next. Where does the food coloring (contamination) end up? (Answer: in the soil and ground water) Does all the contamination just go down into the soil at once? (Answer: No, it travels in little streams.) Does the contamination travel faster in the soil or the aquifer? (Answer: in the aquifer) Why do you think this happens?
- Ask students to answer the questions in the demonstration section on their sheet.
- Discuss with students how engineers would use the information they learned in this demonstration.

Group Activity
Day 1

- Divide students into groups of three to four.
- Distribute supplies to each group (two transparent cups: one for one cup of plain water and the other for one cup of "contaminated" water; two white carnations; a mixing spoon; two pieces of masking tape; and a card with their "contamination" instructions).

- Ask students to record their "contamination instructions" on their Observation Worksheet. On one piece of their masking tape, ask them to write "Contamination" and stick it carefully on the outside of one of the plastic cups.
- Have students label the other piece of masking tape with "No Contamination" and place the masking tape on the outside of the second plastic cup.
- Ask groups to select one member to fill the cup labeled "No Contamination" with plain water (either from a classroom faucet or from a jug/bucket at a designated area in the classroom).
- Ask students to mix their contamination solutions, according to their "recipe" cards. (Note: Set up one to two different stations and have groups go to the station two groups at a time to measure/mix their contaminations.) Remind them to measure their ingredients carefully and to wipe off the measuring spoon after its use. They should then proceed to the designated water station and add one cup of water to their contamination cup.
- Have groups add a different color of food coloring to each of their two cups of water. (Note: Student should not mix colors; just add two drops of one color to one cup and another color to the second cup.)
- Tell students that they will eventually be putting their carnations in each cup of water. Ask them to write a prediction about what will happen to the carnation as it sits in each cup.
- Have groups carefully cut the stems of the carnations so they are about six inches long. Then have them place the stem of one carnation in each of the contaminated and non-contaminated cups of water.
- Ask them to write down their observations for Day 1 on the Observation Worksheet.

Days 2-7

- Ask students to record their observations of the interaction between the solutions and the carnations each day for a week. (How have the solutions and carnations changed? Ask them to consider why this is happening. You may want to discuss some of the results as a class.) Note: Students can cross off weekend days.
- After writing down their last observations (Day 7), ask the students to answer the questions at the end of their Observation Worksheet
- At the end of the observation period, ask the class which carnation they think was the least affected? Why? Which on was the most affected? How was it affected? Why do you think this happened? (Answer: They will most likely say the other ingredients in the water caused the problems, but try to get them to explain exactly what they think their specific ingredient does to the flower.)
- If time permits, have each student group show their carnations and explain the pollution present in their contaminated water. As a class, discuss the effects of the different "contaminations."

Student Engagement

Social/Emotional Engagement: Students will use social, interaction skills for completing experiment with peers.

Physical Engagement: Students will conduct experiment in small groups.

Cognitive Engagement: Students will work together to understand how contamination affects water and plants.

Evidence of Learning

Checks for Understanding/Expected Outcomes

Pre-activity assessment

- Predictions: Using the appropriate spaces in the attached Observation Worksheet, have students predict what will happen in both the demonstration and the activity.

Activity-embedded assessment

- Observations: Using the Observation Worksheet, have students record their observations of the activity for one week.

Post-activity assessment

- How can we use what we learned to help us understand real life problems? (Answer: It helps us understand how pollutants are transferred from water to other systems so that we better know how to prevent the transfer; so that the rest of the food chain is not also affected.)
- Summarize what each of the experiments (demonstration and group) taught us. (Possible answer: Pollution present in water contaminates other systems: the ground, ground water and plant life.)
- How do pollutants get into our water supply? (Answer: Some pollutants get there by leaching through the ground during rainstorms.)
- How do engineers help clean up pollutants in water? (Answer: Environmental, civil and chemical engineers design technologies and treatment facilities to ensure that drinking water is safe. Also, engineers know how to protect and use this water table to help keep that water safe.)

Contaminated Water

Demonstration

Demonstration Prediction:

Reflection/Reaction to Demonstration: Were your predictions true?

Group Activity

Our contamination is made of _____ .

Predictions:

I predict that these things will happen when we put our carnation in the plain water solution:

I predict that these things will happen when we put our carnation in the water solution with food coloring:

Day	Observations
Day 1	
Day 2	
Day 3	
Day 4	
Day 5	
Day 6	
Day 7	

EXIT SLIP:

How were your carnations affected?

Why do you think these things happened?

What kinds of things do you think pollute the water in real life?

What do you think would happen if the carnation lived, but remained contaminated? (Hint: Think about what would happen if an animal came along and ate the contaminated flower.)

How can we use what we learned to help us understand real-life problems?

Summarize what each of the experiments (demonstration and group) taught us.

How do pollutants get into our water supply?

How do engineers help clean up pollutants in water?

EXIT SLIP: Teacher Information

How were your carnations affected? Answers will vary: died, brittle, changed color

Why do you think these things happened?
One possible answer: absorbed the contaminates

What kinds of things do you think pollute the water in real life?
Answers will vary: trash, pesticides, detergents, companies' by products

What do you think would happen if the carnation lived, but remained contaminated? (Hint: Think about what would happen if an animal came along and ate the contaminated flower.) One possible answer: could poison other species causing domino effect

How can we use what we learned to help us understand real life problems?
Possible answers: Awareness of what is in our water table. What causes species to become sick?

Summarize what each of the experiments (demonstration and group) taught us.
One possible answer: How different contaminants can have a direct effect on a species, but also an indirect effect on other species.

How do pollutants get into our water supply?
Possible answers: companies, sewer, plants, and people's garbage

How do engineers help clean up pollutants in water?
Possible answer: identifies problems, creates filters and other solutions, gets products banned

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