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How Does Water Become Polluted? Helping Elementary Students Learn How to Prevent Pollution

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How Does Water Become Polluted?

helping elementary students learn how to prevent water pollution

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ABSTRACT: Through making observations of mixing various items with water, students develop ideas about how pollution happens. The cumulative effect of what happens when many people add only "a little something" to the water provides students with a concrete representation of what can happen in their own communities. Students complete the lesson by determining what they can do to prevent pollution from happening in their own communities. *This activity promotes National Science Education Content Standards A, B, and F, and Iowa Teaching Standards 1, 2, 3, 4, 5, and 6.*

Our second grade classrooms are learning about their community and responsibilities that the students have in the community. Thus, learning about water pollution and its effects on the community is a natural extension for the students' learning. Students in second grade need concrete representations to make connections and develop robust understanding of content (Kolb, 1984). This lesson was carried out over three days and followed the format of the learning cycle; starting with exploration, progressing to concept development, and finishing with real world application. The inquiry-based format was used to promote students developing a robust understanding of the content while also learning about the nature of science including that science involves open-ended exploration, creativity, formulating and changing ideas, working with others, and follows no single, rigid scientific method. The learning cycle model has been identified by the National Center for Improving Science Education as an effective framework in developing science inquiry-based lessons (Bybee, et al., 1989).

Day 1: Exploration

The premise of the exploration stage of the lesson is to encourage students to see what happens when different items are added to water. The focus of today is to explore and think about how different items affect water.

The lesson begins with a teacher demonstration. A clean glass of water is set out for the students to see. Before adding pop to the water, the teacher asks students the following questions:

- What do you think will happen when I pour the pop into the water?
- How do you know or why do you think so?

Open-ended questioning promotes student learning as students are encouraged to use their prior experience and schema to think about what might happen. We know from constructivist learning theory that students learn by linking new learning to their existing schemas. Furthermore, asking open-ended questions promotes our goals for

students, including improving our abilities to learn. In real world learning, we often predict what will happen before actually testing our ideas or moving forward.

DAY 1 MATERIAL LIST

- clear plastic cups (4 per group + demo set)
- stirrers (2 per group)
- water pitcher
- water
- vegetable oil
- soda pop
- liquid soap
- candy wrappers (1 per group)
- poster sheets of paper (4 total)
- marker

We typically write student responses and predictions on a piece of poster paper. Before dumping the pop in the water we ask:

- First, what is an observation?
- How can we make observations?

After pouring some pop in the water we ask:

- What observations can you make about what happened?

If students appear to need a scaffold for the questions or they appear uncomfortable answering on their own, we have students turn to a partner and share their ideas before sharing aloud with the whole class. Social learning theory informs us that when students share with one another, they think of new ideas and build on their own ideas to develop more profound understanding. Furthermore, students are more likely to use language that is intelligible to other students.

After the teacher demonstration, students are told that they will work in groups to explore what happens when various ingredients are added to water. Each group is provided four clean glasses of water, four items to mix with each cup of water (we use pop, soap, vegetable oil, and a paper candy wrapper), and a few stirring sticks (popsicle sticks). Have students predict what will happen when each item is added to a cup of clean water. Then have each group mix the item with the water and make observations. Groups receive four slips of paper on which to write/draw their predictions and observations. The slips of paper will be taped to four poster papers (Figure 1) titled *pop, oil, soap,* and *candy wrapper.*

The questions above help us assess the extent of our students learning up to this point. In addition, the teacher demonstration is important because the teacher may need to assess student learning about how students are making observations before students actually make observations on their own in groups. Most noticeably, students sometimes confuse observations and inferences. We try to help students focus on observations by reminding them that observations are things we can see, touch, or hear rather than something we think.

After providing directions and assigning students to groups of about four, we let students go and explore on their own through making predictions and observations about the various mixtures. During the group work session, students learn from one another and work toward goals of developing effective communication, respecting materials and surroundings, developing curiosity, and working toward a robust understanding of the content. We walk around to the various groups to watch and listen to students so we can assess their learning. Walking around the room also helps to maintain classroom management and gives us the opportunity to provide scaffolds and prompts for groups who have difficulty.

When students appear to have completed their explorations and have posted their prediction/observation slips on the poster papers, we bring the students back together as a large group. Sitting on the floor together may be advantageous in order for students to hear one another during the following discussion. The teacher and students can additionally use the poster papers to refer back to their exploration session.

FIGURE 1

Sample paper slip for recording observations.

SOAP
Predictions:

Observations:

Initiate a discussion based around questions such as:

- What did you notice happening when you mixed the water with the oil, water with the pop, water with the soap, and water with the candy wrapper?
- How were your predictions similar or different to what you observed?
- Why do you think the _____ mixed differently than the _____?
- Why would you or why would you not like to swim in the vegetable oil and water mixture?

At some point make sure students realize that the items impacted the water differently. Some items floated, some sank to the bottom, some mixed together. They all did different actions to the water. Throughout the discussion, make sure to consistently use extended answer questions, acknowledge student ideas, and then use student ideas to move forward with the discussion. For example, if students note that the soap did not mix with the water right away ask,

- "How do you think the soap is like the vegetable oil?" or
- "Why do you think soap is used for cleaning?"

Asking scaffolding questions is only part of conducting an effective discussion with young children. We also scaffold the discussion itself. That is, sometimes before a question, we explicitly tell students we want them to think to themselves for a few seconds before answering a question. We also explicitly ask the class what they think of a student's idea. Students often do not listen to one another, so we often have to ask the initial student to repeat himself or herself. Over time, we remove these explicit scaffolds as students gain the skills to have a discussion rather than a share-a-thon. Additionally, we are careful about how we react to student responses. We do not reject student comments or overly praise students. Instead, we work to acknowledge the ideas and ask for elaboration on their thinking.

To connect to what students will be learning the following day, we have students turn to a partner and make a prediction as to what might happen to the water if we added all of the items to one glass of water.

Day 2: Concept Development

Concept development is the next stage in the learning cycle and in this stage we build on the previous lesson to develop the concept of pollution. We start by activating the students' prior knowledge and review the big ideas from the previous day. To get started, we ask questions such as:

- Identify one thing we did in the activity yesterday.
- What is one big idea from the activity yesterday?

We encourage several of the students to respond and provide the students time to think about what their classmates are saying. Proper wait time will help the students access their prior knowledge and discuss their ideas - both accurate and inaccurate. The initial discussion is designed to access the students' prior knowledge so they can be ready to add new ideas. As students share their ideas, ask them to explain their answers. Use students' answers to ask new questions about the activity. When a student mentions that we made observations, refer to the wall charts that were made the previous day and encourage students to share their observations from the previous day. Sharing yesterday's observations will help students remember some of the smaller details. As students are sharing, we can assess student learning and determine how to transfer into today's activity.

The next part of the lesson will involve mixing vegetable oil, soap, and pop in the same glass. The design is to build on the big idea that items mix into water and change it. Adding multiple items into the same water source will demonstrate the cumulative effect of several people adding something small to the water. Ask students to make predictions of what will happen when we mix all three items into the same glass of water. After making their predictions have them work in their groups to observe what happens when all the substances are mixed together.

Set up work tables beforehand with samples of oil, soap, and pop, a clean glass of water, and stir sticks. An effective classroom management procedure is to tell students that if they did not get to mix in an item the day before, then they get to mix in an item today. This helps to include all students and not leave anyone out. Tell students to mix the items into the water and make observations. After some exploration, encourage students to share their observations with the class. Effective questions during the class discussion might include:

- What did you observe happening to the water as you mixed the items?
- How did the water change as you poured in the items?
- How did the different substances affect each other?

The next part of the lesson is where students take what they observed when mixing three items together and expand it to a larger water sample (a small aquarium or large clear glass

DAY 2 MATERIAL LIST

- clean cup of water (1 per group)
- stirrers (1 per group)
- water pitcher
- water
- vegetable oil
- soda pop
- liquid soap
- candy wrappers (1 per group)
- poster sheets of paper (from Day 1)
- marker
- aquarium (filled 2/3 full with water)
- large stirring spoon
- small cups each filled with one of the following: army men, matchbox cars, liquid soap, vegetable oil, salt, pepper, hot chocolate mix, plastic beads, golf ball, tea bag, dog food, cereal, popcorn, candy bar, shampoo, sugar, cough drop, glue

bowl works well) with multiple items. See the materials list for Day 2 below. Students will take turns choosing an item from the table, making a prediction on what will happen to the water, and then dumping the item into the water. Note that students' observations will vary depending on the order the items are added.

To keep track of the class' observations we ask students to have their notebook (or piece of paper) and write an observation after each item/substance is added to the water. Be sure to stress that we are predicting the *impact on the water*. Placing all of the items in small cups makes it easier for the students to select the item. A classroom management tip is to use name sticks to randomly choose the next student. The name sticks ensure that everyone gets a turn and that the order is random. After every three to four students, pause and have the class share observations about the water. Write down some of the key observations on the easel to track the changes in the water. Once every student has dumped in an item, make final observations and then move to the class discussion.

Initiate the class discussion with questions such as:

- How would you describe this water?
- Why did the water change from being clear at the beginning of the lesson to how it is now?
- Each of us only put in one small item. How did the water become so dirty?

Students will recognize that although each individual only added one thing, the total effect was to make the water very dirty. When the students allude to this ask,

- Many people believe it's not a big deal to throw their candy wrapper on the ground. Based on our water investigation, why *is* it a big deal?

Now is a good time to discuss the vocabulary words *pollution* and *littering* as students now have rich experiences from which they can connect the terms. Link the concept of pollution to their communities with questions such as:

- Where are some places in our community where pollution can happen?
- Where does pollution happen in our community?

To further help students make connections between the activities and pollution in the community, we show students pictures of pollution such as those below. When we show them the pictures we ask them how the picture is like the water with which they have worked.

Day 3: Application

The premise of stage three of the learning cycle is to have students apply what they have learned throughout the previous lessons. Therefore, the focus of today is to encourage students to apply their knowledge of pollution and the effect it has on their communities.

We begin the lesson by displaying the large sample of polluted water that the students created in the previous lesson. Ask students to pretend that the container of water is a lake in their community. Initiate a brief class discussion to activate student's prior knowledge gained during the exploration and concept development stages by asking:

- What is pollution?
- What have you learned about pollution over the past two days?

Open-ended questions are a crucial element to an effective teaching episode and pertinent to the application phase. The application phase must provide students with many opportunities to share and discuss their thoughts. This type of environment will set up students for active mental engagement and making connections among their ideas and experiences.

After students have shared what they know about pollution (including that small things like littering can create big problems if enough people contribute), use their ideas to

SAMPLE PICTURES

Photo by John Nyberg
http://www.sxc.hu/photo/932064

Photo by Kristin Smith
http://www.sxc.hu/photo/550264

Photo by Jenny Rollo
http://www.sxc.hu/photo/762318

transition to a task that gets students moving. This task encourages students to synthesize the fact that pollution hurts animals in the community as well as people. This connection sets them up for the final application assignment, *We Are Fish* (see text box on the next page). This task also might serve as an informal assessment, so the teacher can determine if any important pollution concepts need to be reinforced.

We Are Fish

This task is a continuation of the opening class discussion and should take approximately five to seven minutes. Put the large container of polluted water on one side of the classroom and a clean glass of water on the other side of the classroom. Then present the following scenario:

Pretend you are a fish and you have the choice to live in this water (polluted) or this water (clean).

Direct students to answer the question by walking and standing on the side of the room where they choose to live. Follow up with the following thought-provoking questions:

Note: Our class was positioned by the polluted water when I asked the question and every student decided to move across the room to choose the clean water.

- Why did you chose to leave?
- I'm a fish that wasn't able to leave this water. What are some things that you can do in your water that I can not do in my water.
- Who else can water pollution hurt? Why?

Students usually have an intuitive sense that the clean water is better for fish, but sometimes struggle with the second question above. Scaffolding questions might include:

- What do fish need to live?
- How does the pollution keep fish from being able to do that?
- How might the pollution make me (the fish) less safe from predators?
- What do you think might happen to a predator that ate a fish from this water?

End this task by transitioning students back to the carpet or group discussion area by presenting the following scenario:

Which would be better for our community and the animals living in this water; to try and clean up the pollution or to not pollute in the first place? Come to the carpet and sit down if you think it is better to not pollute. Stay where you are if you think it is better to try clean up the pollution.

Note: Every student moved back to the carpet.

Follow up the *We Are Fish* task by asking students this question in a Think-Pair-Share format:

- Why do you think it is better to find ways to help stop/prevent pollution instead up waiting to clean up pollution after it has already happened?

DAY 1 MATERIAL LIST

- clean cup of water
- polluted water (from previous day)
- poster paper
- markers
- crayons
- *Bernstein Bears Don't Pollute (Anymore)* book

As students are discussing their thoughts with each other use this time to listen in on their conversations. During this time students are sharing thoughts with peers, listening, and learning from others. When students have all had a chance to share with each other the reasoning behind their decision, ask a couple of students to share with the whole class.

Transition the lesson into a read aloud of "Bernstein Bears Don't Pollute (Anymore)." This book talks about pollution, various ways pollution has hurt Bear Country, and how Brother and Sister Bear helped stop and prevent pollution in their community. Because students already have so many experiences with and have discussed pollution, we stop during the reading to ask students questions about how the story is like what they have done in class.

After reading the book ask students to discuss the following questions with their partner:

- What are things Brother and Sister Bear did to stop and prevent pollution?
- What are other ideas that were not told in the story, but you would like to add?

After some partner time, assign students to groups of two and have them create a poster that shows how *they* plan to help stop or prevent pollution in their community. This collaborative application assignment promotes effective communication, demonstrating a robust understanding of content, demonstrating effective problem solving strategies, and creativity. As students work on their posters, walk around the room to ensure students are staying on task. Finish the lesson by hanging the posters on a wall or in a hallway and encouraging the students to view and ask questions about each other's posters.

Conclusion

This lesson plan is developmentally appropriate for second grade students and follows the learning cycle. The activities and format of the lesson are based on a research-based framework for teaching science (Clough & Kauffman, 1999) that is supported by what is known about how people learn and provides ample opportunities for us to promote our goals for students such as creativity, independence, problem solving, cooperation as well as content

understanding. Furthermore, because the lesson is not a simple "follow the direction" activity, students are less likely to think science is a dull, boring, and a procedural task.

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