Dublin San Ramon Services District
Water, wastewater, recycled water

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Lesson Plan

5th Grade: Every Drop Counts

Suggested Time of Year

This lesson is about recycled water and how it differs from potable water. Scientifically the lesson relates to molecules and atoms and what happens to a molecule when it is added to water. Does it dissolve or stay suspended as in a colloidal suspension? Students strictly adhere to the scientific method in conducting water tests. They use tables and graphs to total all the results, and they employ mathematical reasoning to draw conclusions.

This lesson relates well to the theme of people and conflict. It provides an example of how water plays an integral role in people's lives and may affect where they settle. It shows how water can be a defining natural resource.

Basic Concept

Recycled water! The total amount of water on Earth is compared to the amount of available, potable (drinkable) water on Earth. The lesson emphasizes the scarcity of drinking water as a resource and introduces the benefits of recycled water.

Contents

Lesson Plan

Organizational Considerations

Classroom Time: 50 minutes

- 5 minute introduction
- 15 minute water demonstration
- 10 minute explanation of how to test water
- 10-15 minute student water tests
- 5-10 minute closing and assessment

Classroom Organization

Whole class for introduction and preliminary discussion, then the class is divided into 4 or 5 equal groups. The whole class meets again to combine data and for closure.

Required Student Skills

The students need to be able to work in groups, perform simple lab tests and fill out the required data sheet.

Major Objectives

Pre-class Set-up

See the Preparation Checklist (at the end of the Lesson Plan) at least two weeks in advance. Contact DSRSD Public Information (925-875-2282) for more information on equipment and supplies that may be available to borrow. A table and overhead projector are needed for the demonstration.

Learning Statement

Students learn about recycled water: what it is, how it differs from potable water, and why we should recycle water.

Behavioral Statement

Students perform hands-on laboratory tests and record results on a data sheet.

Child Development Statement

Children at this age are in transition between Piaget's Concrete Operations and Formal Operations. Each child's response to this lesson will vary, based on age and level of development. The hands-on water tests help students who are closer to Concrete Operations. Students who have reached Formal Operations can perform more scientific reasoning and draw conclusions about the importance of recycled water.

Vocabulary

Recycled Water: Wastewater that has been treated (cleaned) to a level that meets or exceeds the health and safety requirements for uses that don't involve human consumption (such as watering plants at golf courses, parks, and playing fields). Stated simply, the process of recycling water separates the solid and liquid portions of wastewater; the liquid portion is filtered, sanitized, and then used for specific purposes; the solids are disposed of properly.

Potable (poe-ta′-ble) water: Fresh water that is available for drinking.

Turbidity: A measurement of how much light is scattered by undissolved particles in a fluid.

Total Dissolved Solids (TDS): Chemicals that dissolve in water but do not affect turbidity (turbidity measures particles that do not dissolve).

Hardness: The amount of calcium or magnesium in water (chemicals that are not harmful to humans but can cause skin irritation from residue and leave deposits in pipes).

Ammonia: A byproduct of urea that is found in urine. Plants require ammonia for growth.

Nitrates/nitrites: Substances found in all cells that are broken down into nitrogen (an important element used in photosynthesis).

Wastewater: Water that goes down drains and toilets at homes, businesses, and schools. Wastewater is treated (cleaned) at the wastewater treatment plant and then either recycled or disposed of properly.

Delivery of Instruction

1. Set-up

- Pour 1000ml of potable water into the 1000ml graduated cylinder and add 12-15 drops of blue food coloring. Set it and the remaining cylinders, the 4-inch square of plastic, and the globe on the demonstration table.
- Set up overhead projector.
- Place all items for student tests in a location where students can pick them up.

2. Warm-up

"How many of you used water today for some reason?" [Students raise their hands.] **"We use water all the time and we need it to survive. Today we are going to talk about the availability of *potable* (poe-ta-ble) water and how we can make more of it available by recycling water.**

"Our local water utility, Dublin San Ramon Services District, provides the drinking water that comes out of our faucets. But they also have been recycling water since 1999."

Hold up the inflatable globe or use the classroom's globe.

"About 71% of the Earth is made up of water; however not all of that water is available for us to drink. Let's imagine we can squeeze all that water out of the earth and put it in this cylinder."

Pretend you are squeezing the water into the 1000ml cylinder that contains the blue water. Put the sign *Total Water on Earth* in front of the cylinder. Line up the other graduated cylinders of various sizes and ask the students to estimate which one represents the amount of water on Earth available for us to drink. Hold up each cylinder and then write the votes on the board.

"Let's find out how much of Earth's water is available for us to drink."

3. Teacher-directed instruction

"Where do you think most of the water on Earth is located?" (The oceans.) **"Ocean water is salty and is not drinkable. In fact if you drink too much salt water it will make you sick."**

Pour 30ml from the 1000ml graduated cylinder into the 50ml graduated cylinder. Change signs.

- Use *Salt Water* for the 1000ml cylinder, which now has 970ml left in it.
- Use *Remaining Water* for the 50ml cylinder.

Point to Antarctica on the globe. **"A fair amount of the remaining water is in a form we cannot drink. Can anyone guess what form it is in?"** (Frozen/ice.) **"About 8 years ago some scientists tried to float big icebergs south from Alaska for fresh water but it was not economically feasible. However, that might change someday."**

Pour 6ml out of the 50ml graduated cylinder into the 25ml graduated cylinder and change signs.

- The 50ml cylinder is now labeled *Frozen Water*.
- The 25ml cylinder is now labeled *Remaining Water*.

"Much of the remaining water is located underground and is called groundwater. It is also hard to get at. Does anyone here have a well in their backyard?" [Some students will, but most won't.] **"Most of us get our water delivered through pipes, which is one of the services performed by Dublin San Ramon Services District."**

Pour 1.5ml from the 25ml graduated cylinder into the 10ml graduated cylinder and change signs.

- The 25ml cylinder is now labeled *Groundwater*.
- The 10ml cylinder is labeled *Remaining Water*.

"Now, is the remaining water ready to drink? Can you go to any river or stream and drink the water?" (No.) **"Now we will separate out the amount of water that you can drink."**

Using the dropper, take one drop out of the 10ml graduated cylinder and drop it on the 4-inch square of plastic.

"You can see that although there is a lot of water on Earth, very little of it is available for us to drink. This one drop represents how much water is available to us. And all living things need water to survive. The amount of water on Earth today is the same amount as billions of years ago. More and more people and animals inhabit the Earth today, so potable water will become less and less available. We need to properly manage our water.

"Today we will be doing a hands-on activity, doing the same tests on water that our technicians do in the laboratory. Before we begin, we need to go over a little bit of background information that will help you interpret the results."

- Use the 5 overheads in this order: Turbidity, TDS, ammonia, hardness, nitrate/nitrite.

NOTE: Ammonia, hardness, nitrate/nitrite are dissolved solids, as is mentioned on the last line of the TDS overhead.

"By recycling water, that is, using recycled water on plants and grass instead of discharging it with waste, we save our fresh water for drinking. DSRSD uses recycled water on local golf courses, parks, some schools, and some road medians. See this sign?" [Hold up the recycled water sign.] **"Whenever you see this sign, it means recycled water is being used. Another way to tell is to look at the sprinkler heads. If they are purple, then the water coming out of them is recycled water. Even the pipes underground are purple. This tells us that the water is recycled, so we should not drink it.**

"We will now be running some experiments. We will find out what substances in recycled water make it different from potable water and why it makes perfect sense to use recycled water on plants."

3. Modeling/Guided Practice

Using the teacher's guidance, divide the class into groups. Each group will be responsible for a different test and will divide themselves into two sub-groups: one will test drinking water and the other will test recycled water. You will gather all test results and write them on the board.

✓ *It is very important to demonstrate how to hold a test strip level (horizontally) and point out that the "pad" is located on one side of the strip only. Usually 5th graders have never seen a test strip. Also emphasize the importance of timing. Demonstrate how to count seconds (one thousand one, one thousand two) or have students use the classroom clock or a wristwatch with a second hand.*

"I need everyone's attention as I give the instructions you need to do the tests. I only give instructions once."

"Most of you will be working with test strips and two groups will be working with instruments. I'm going to show the whole class how to use test strips and then I will show the individual groups how to use the instruments."

[Hold up a Ziploc bag.] **"You are going to receive a bag like this. Each student will get one bag and do one test. Inside the bag is a piece of paper and a test strip. When you get your bag, remove the test strip but leave the paper in the bag; we do not want it to get wet. "**

"Notice that there is a square pad on one side of the test strip. When the instructions say, 'Hold the strip with the pad side towards you' or 'pad side up,' this is the 'pad.' [Point to the pad.] **When the instructions say, 'Hold the test strip level,' it means to hold it like this."** [Hold the test strip horizontally with the pad up].

"When the instructions say 'Dip,' they mean you should hold the test vertically and move it up and down in a smooth motion. Also, a swish is like this." [Show them.] **"I know it might sound dumb that I am explaining all of this, but if you do not do each step correctly you will not get good results."**

"In your bag there is a small piece of paper. On one side is a set of instructions and on the other side are small colored squares. Read all the way through the instructions before you begin. This is important because with some of the tests you read results right away, while with others you wait 30 seconds. You have to know what you are doing next."

"To read the test results, compare your test strip, pad side up, to the square. Match it to one of the squares, to the best of your ability. The squares have numbers under them; these are the numbers you write on your data sheet."

"When you are finished, write on your sheet the results of other students in your group. When everyone is finished we will compile all the class data. Always write your own readings, not your neighbors or the reading you think is expected. The essence of science is to write down what *you observe* and then draw conclusions or ask more questions based on your data."

Point out these details:

- Nitrate/nitrite: DO NOT shake off excess water
- Hardness: only dip for one (1) second
- Ammonia: show how to move the dipstick up and down in water; also point out that it has 2 test pads on it

Have the students break up into their groups. Ask each group to send one representative to get their group's materials.

✓*It works best if you can set up the "kits" on a back bench or table and then go back there when you explain what to do and how to use them.*

Tell the groups that will be using the instruments that you will show them what to do when the rest of the class gets started. (See below.)

Pocket Pal

Directions are in the Ziploc bag marked *TDS Testers*. Turn it on (button on top), let it read to zero, place water sample in it, and gently stir sample for 5-10 seconds. When the digital display stabilizes, read the TDS Value (Total Dissolved Solids).

Colorimeter

Instructions are in the colorimeter case. Turn on the device by pressing the *Exit* button. Remove the cover from one portion of the colorimeter to reveal the sample well. Select vial marked *DW* (Distilled Water). Wipe off fingerprints with a Kimwipe and then hold the vial by the cap only. Put the vial in the well, press the *Zero* button, wait until the display reads "0." Explain what you are doing to the students while you are doing it. They only have to "zero out" the instrument when they first turn it on. After that, each student takes a turn with one vial. Each one presses the "read" button and then writes down the 3-digit number on the display. The readings are in FAU (a unit of measurement).

✔ *An adult should fill the colorimeter vials and let the students read results. It is difficult to pour the water into the vials accurately.*

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4. Check for Understanding

Ask if there are any questions. Go over the specifics of each test again and have the students in each group repeat the instructions back to you.

5. Practice

Tell students to begin. Both you and the teacher should circulate, encouraging students and making sure they are on task. Then go to the instrument groups and show them what to do. The actual testing should only take about 5 minutes.

✔ *It is very important to leave enough time at the end of the lesson to compile the data and allow the students to reach conclusions.*

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6. Assessment and Closure

The assessment for this lesson is the discussion of students' results. Obtain the readings from each group and tally them on whiteboard or an overhead. Ask the students to suggest information they can determine from the data chart. If no one volunteers, pick a student.

Example: "I noticed that the turbidity is higher in the recycled water." Go through each test, pointing out differences and similarities between potable and recycled water.

"Here's the question of the day. This is where I can tell who is truly listening and thinking! Remembering the information that was on the overheads, and given the results of your tests, what can someone tell me about recycled water?"

(Recycled water is better for plants because it has higher levels of Ca, Mg, Ammonia, Nitrites and Nitrates. Plants need all these things for photosynthesis.)

"It is a natural fit. By recycling water, we save potable water for ourselves; and the plants prefer and grow better with recycled water."

PREPARATION CHECKLIST

Important Note
At least two weeks in advance, contact DSRSD Public Information (925-875-2282) for more information on equipment that may be available to borrow.

Pre-class Preparation – Two Weeks Ahead

- ☐ Arrange to borrow equipment from DSRSD (see above)
- ☐ Order test strips from Hach Company, World Headquarters, P.O. Box 389, Loveland, CO, 1-800-227-4224, www.hach.com
    - Ammonia Test Strips (Hach Cat. 27553-25) 25 strips
    - Total Hardness Test Strips(Hach Cat. 27452-50) 50 strips
    - Nitrate/Nitrite Test Strips (Hach Cat. 27454-25) 25 strips

    Each student does one test. Each group will be responsible for a different test and will divide themselves into two sub-groups: the students testing drinking water and the students testing recycled water.

    Make sure you have enough **test strips**, one per student. If using a colorimeter, spectrographic vials with tops are required.

Pre-class Preparation – 72 Hours Ahead

- ☐ Pick up equipment from DSRSD
- ☐ Obtain recycled water at the DSRSD Wastewater Treatment Plant and de-ionized water from the laboratory at the Wastewater Treatment Plant.

Pre-class Preparation – 24 Hours Ahead

Assemble equipment and student materials.

- ☐ 1 - 1000ml graduated cylinder
- ☐ 1 - 50ml graduated cylinder
- ☐ 1 - 25ml graduated cylinder
- ☐ 1 - 10ml graduated cylinder
- ☐ Put test strips, test instructions, and color chart, in small Ziploc bags, one per bag
- ☐ Print data sheet, 1 per student
- ☐ 1 Ziploc bag cut into a 4"square or waxed paper (store inside the graduated cylinder)

- □ 5 - 32oz. Ziploc containers w/lid marked *Recycled Water*
- □ 5 - 32oz. Ziploc containers w/lid marked *Drinking Water*
- □ Small clear plastic signs: *Total Water on Earth, Remaining Water, Salt Water, Frozen Water, Groundwater*
- □ Inflatable or regular globe
- □ 1 red-capped, 5-liter water container for recycled water
- □ 1 blue-capped, 5-liter container for fresh water
- □ Blue food coloring
- □ Two TDS Pocket Pal readers
- □ One plastic squirt bottle containing de-ionized water (used to clean the TDS testers between tests)
- □ Colorimeter
- □ 14 marked spectrographic vials with caps for colorimeter
- □ Kimwipes (to clean colorimeter vials)

✓ *If you are presenting in multiple classrooms, allow 15 minutes between presentations for setup. Allow less time (5 minutes) if you can remain in one location. If several classes are done consecutively, you may need to restock Ziploc bags with test strips.*

Turbidity Test Instructions

1) Wipe down glass vial with a "Kimwipe."
2) Place sample inside reader and cover.
3) Hit the "Read" button located at the bottom of key pad.

Ammonia Test Instructions

1) Dip the strip into the water sample, and move up and down in water sample for **30 seconds**, making sure both pads are always submerged.

2) Remove the test strip and shake off excess water.

3) Hold the test strip level, with pad side up, for **30 seconds**.

4) Turn test strip over so that both pads are facing away from you, and compare the color of the small pad to the color chart on back.

Nitrate/Nitrite Test Instructions

1) Dip the strip into water for **1 second**. Do not shake off excess water from the test strip.

2) Hold the strip level, with pad side up for **30 seconds**. Compare the NITRITE (pad towards middle) test pad to the color chart.

3) At **60 seconds**, compare the NITRATE (pad towards end) test pad to the color chart on back.

Hardness Test Instructions

1) Dip the strip into water for **1 second** and remove.

2) Shake off excess water.

3) Hold the test strip level, with pad side up, for **15 seconds**.

4) Compare test pad to the color chart on back.