Dublin San Ramon Services District
Water, wastewater, recycled water

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Lesson Plan

7th-8th Grades: Take the Water Filter Challenge

Suggested Time of Year

This very "hands-on" lesson, which discusses water treatment and stresses the scientific method, can be taught at any time of the year. It is well suited for 7th and grades, and the students love it.

Basic Concept

This lesson teaches students problem-solving as it relates to water. They learn about the wastewater treatment process and then are asked to "put on engineering hardhats" and work with a group to design a water filter. The lesson stresses treatment of water and the scientific method.

Contents

- Scripted Lesson Plan
- Preparation Checklist

Lesson Plan

Organizational Considerations

Classroom Time: 50 minutes

- 5 minutes, warm up
- 5 minutes, activity instruction
- 5 minutes, design filters
- 10 minutes, build filters and test
- 20 minutes, analyze results, wrap up and clean up

Classroom Organization

Whole class for introduction, then students work in teams, usually four to five per lab group. The whole class meets again to analyze results and discuss conclusions.

Required Student Skills

Students must be able to work in lab groups with minimal supervision.

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) to borrow all equipment and supplies. On day of lesson, set up station where students will pick up materials. Set up colorimeter station. Mix a small amount of potting soil in a plastic cup of water, one per group.

Learning Statement

Heighten student awareness of wastewater treatment and introduce the benefits of recycling water. We want students to learn how to work in a team to solve a common problem, such as why we need to recycle water, and to understand that the problem-solving process involves asking and answering a series of questions.

Behavioral Statement

Assess students' understanding of the lesson through their answers to the questions at the end of the script. Students assess the effectiveness of their filters by measuring water clarity.

Child Development Statement

Students in 7th and 8th grades are 12-14 years old and therefore are at the end of Piaget's spectrum. They exhibit functional understanding, reverse logic, and logical thinking, so they can think through the filtration problem.

Vocabulary

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

Recycled water: Wastewater that has been separated from solid waste and then further filtered, treated, and sanitized so it can be used to water plants.

Delivery of Instruction

1. Warm-up
Write the text below and wastewater treatment diagram on the white board:

Dublin San Ramon Services District
- Fresh water
- Wastewater treatment
- Recycled water to water plants at:
  - Parks
  - Golf courses
  - School fields

Say, **"Does anyone know where most of our drinking water is stored?"** (Primarily in the Sierra Nevada mountains in the form of snow.) **"This is why we often see news reports about the snow in the Sierras. It's not just about skiing and snowboarding. It's about how much water we will have available for the spring and summer."** Explain that Dublin San Ramon Services District is the local government agency that distributes water in Dublin and parts of San Ramon. DSRSD also treats wastewater and recycles water.

Ask, **"Where does recycled water come from?"** (wastewater)

2. Teacher-directed Instruction
(See Wasterwater Treatment Process diagram next page)

"Anything that comes from the drains or toilets in your house or a business or a school is wastewater and it flows through sewer pipes to the DSRSD treatment plant.

"At the plant it first goes through a big moving screen that removes rags and branches.

"Then it goes through primary treatment, which removes scum from the water surface and heavy items that sink to the bottom.

"From here the water goes to secondary treatment which involves aeration (pumping oxygen into the water) and microbial action. Microorganisms that "eat" the dissolved organic wastes are added. As theses living organisms multiply, they clean the water further. Then, the water flows into clarifiers, where more sedimentation happens. Blades scrape the bottom of the clarifier tanks to remove the last solid wastes.

"Finally, chlorine is added to sanitize, or 'disinfect,' the water. If the water is not going to be recycled, it is pumped over the hills and dechlorinated before it is sent through an outfall pipe that empties in a deep part of the San Fransciso Bay.

"If the cleaned wastewater is to be recycled then it goes to tertiary treatment, which involves advanced microfiltration and further disinfection using ultraviolet light. Recycled water can be used to water lawns and other plants at golf courses, parks, and schools. You can tell if a field is watered with recycled water because the sprinkler heads are purple. You'll see signs that say, 'Recycled water, do not drink.' Around town, you may see an occasional purple fire hydrant that provides recycled water for construction projects. Even the pipes underground are purple. Recycled water flows through a different set of pipes than our drinking water."

Say, **"What are some things that you see in the wastewater treatment process that relate to building a filter?"**

Desired feedback: There are many steps. Each step handles a different kind, size of "dirt." The thickness of the materials varies. Water must go through the filter (not around it).

Say, **"Think about some of these things as you design your filter. Today you are going to be just like the engineers at the wastewater treatment plant. Your job will be to develop a filtration system for wastewater."**

3. Modeling/Guided Practice

Explain that like the engineers at the treatment plant, students will work in groups to design and build a water filter.

"I can't think of a situation where engineers work alone. They have training in different areas and so must work together to solve different parts of a problem. For instance, a chemical engineer works with chlorine and other chemicals. A seismic engineer gets involved when structures have to be designed to withstand an earthquake of a certain magnitude. Mechanical engineers design how to move all this water in the most efficient way. These are just a few examples of some of the engineers involved in the water industry.

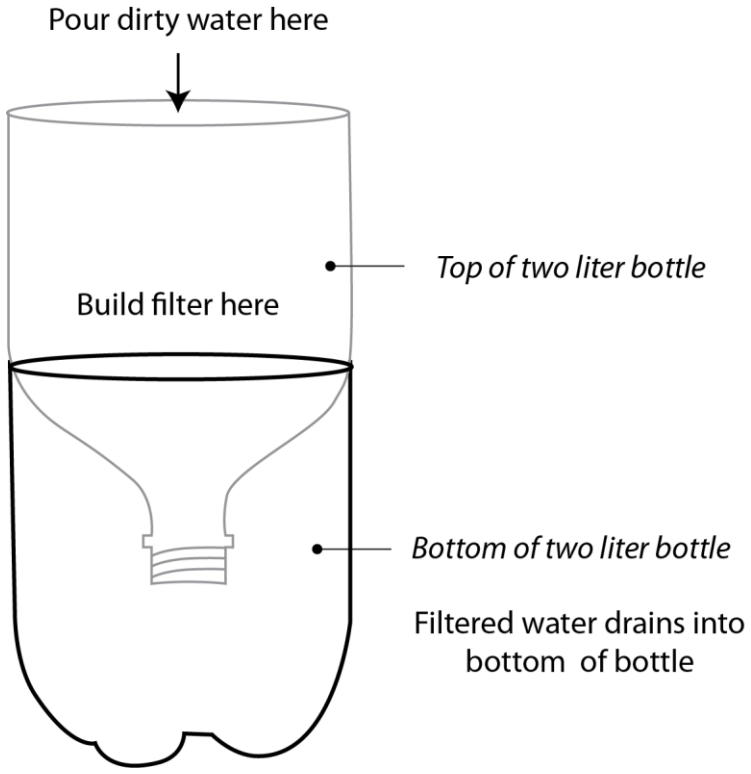
"In your group, each one of you brings different life experiences to the problem so you can all make unique contributions to the development of your group's filter.

"Also, like engineers, you do not have unlimited time or resources. When an engineer is presented with a job, she is not told, 'Take all the time and money you need to get the job done.' Engineers get a deadline and a budget. You, too, will have some constraints on your time and the resources available to you.

"In the back of the room are fifteen items which may be used to build your filter. Each group can choose <u>five</u> items to build its filter. At this point I'm going to give each group this worksheet and then I will give you the instructions." Divide students into lab groups. Hand out one worksheet to each group.

Now hold up the worksheet and say, **"I have just given each group a filter worksheet. I am now going to give instructions. You must listen carefully as I only give instructions once."**

If students are talking stop and wait until the class is quiet. Holding up the worksheet, point to it and say, **"On one side of this worksheet is a picture of the filter apparatus, which is a two-liter bottle, cut in half."** (Point to illustration on the board or hold up a sample apparatus). **"You will build the filter in here** (point to area) **and the water will be captured in the bottom half of the bottle."**



✔ *It is important to emphasize where the filter goes, as some students will put the filter materials in the wrong place.*

"On your worksheet, where the top of the bottle is pictured, draw in the materials you select and show how they will be placed.

"Next to this is a column that says 'Reasoning.' This is where you are to explain why you are using the materials you have chosen. You would not say, 'I'm using this to filter water.' You would say things like: 'I'm using the cotton balls to remove mid-sized particles' or 'I'm using this material because it is porous and I think it will be good for filtering small particles.'"

Now turn over the worksheet so students see the list of items. Say, **"Here is the list of items you may choose from to build your filter. They are all on the counter in the back of the room. With your group you are going to choose five of these—any five you want. But before you can come back and get your materials, you must complete the drawing of the filter you**

plan to build and fill in the reasoning column. When you have completed these tasks, come to the back of the room and I will give you your items. Please, only one person per group should come back there because it gets crowded."

It is helpful to show the materials and briefly describe any items that might be unfamiliar. For example, hold up the cheesecloth and say, "**This is cheesecloth. It is used in cooking and is made of loosely woven cotton."** Hold up the wire mesh and say, "**This is wire mesh. It is like a screen on a window except the holes are bigger."** Hold up the nylon and say, **"This is nylon. It is stretchy and has small holes."**

"Before you make your final material choices you may come back here and look at the materials but DO NOT TAKE ANYTHING. YOU MUST GET MATERIALS FROM ME after your worksheet is completed."

5. Check for Understanding

"Are there any questions about what we are doing? Now is the time to ask because I will not repeat them later." Take any questions before proceeding.

6. Practice

Let the students get started. Tell them they have about five minutes to design their filter or give them a time like, **"You have until 9:50 to design your filter."** Visually check each group to see if they are actively working. If not, go over and ask how they are doing or help them get started.

When a student comes back to get materials, make sure to look at the worksheet. The filter must be drawn and labeled and the reasoning portion must be filled out in a reasonable manner. If not, send the student back for the group to complete the worksheet.

✔*It is important for students to think through the design process rather than just start building a filter.*

Each group should pick up one black, plastic tray to place under their apparatus (catches dirt and spills), one bottle apparatus (top and bottom of a two-liter bottle), and the five items of their choice.

When all the groups have their items, announce an ending time that leaves 20 minutes at the end for discussing results.

Once each group is going well, bring a cup of dirty water to each lab bench. Also bring an empty colorimeter vial and explain that it is for a sample of their filtered water. It should be filled up to the line and then handed to you at the colorimeter station. Point out the number on the top of the vial. Say, for example, "**You are Red 5. Write this vial number on your worksheet."**

As each groups brings up a filtered water sample, show students how to use the colorimeter. Have one student take a reading and write it on the group's worksheet. Compare each sample to

a "blank" (a vial of clean de-ionized water). Be sure to put a clean piece of white paper behind the vials when viewing them.

7. Assessment and Closure

The assessment vehicle for this activity is the water itself. At 20 minutes before the end of the class, stop all work, even if a group is not finished. Groups that finish early can begin cleanup. Dispose of all items except for the two-liter bottle devices. If there is dirt in a water cup, be sure students first wipe out the cup with a paper towel before washing—otherwise drains will clog!

After all samples are turned in, ask a representative from each group to come to the front of the room and, using only their eyes (not the colorimeter readings), place the vials in order, from the cleanest to the dirtiest. List the vial numbers on the board, from cleanest to dirtiest. Point out to students that this is a subjective process.

Then ask for the colorimeter readings for each vial in the list and write these numbers on the white board. Compare the subjective results to the objective data. If there are differences, ask students to suggest reasons why.

Now ask groups with the highest and lowest colorimeter readings to send a representative to the white board to quickly sketch their filters. Point out similarities and differences between the designs.

Finally, ask (insist) each group to share either one thing they learned or one change they would make in the design of their filter. Discuss this in the context of the scientific method, e.g., you find out information and then design another experiment.You do not "fail;" you find a way to accomplish your goal.

✔*Make sure all students have cleaned up before allowing them to leave.*

Resources

Helpful Facts

- The DSRSD plant treats an average of 10.6 million gallons of wastewater per day.
- A single family residence produces, on average, 220 gallons of wastewater per day.

Resources Used in Developing Lesson Plan

- Council for Environmental Education, Project WET Curriculum & Activity Guide Bozeman, MT, 1995), 267-270.

- Westin's "Take the Filter Challenge program description. DSRSD schematic "Understanding the Process" (Aug. 17, 2005)

PREPARATION CHECKLIST

Important Note
At least two weeks in advance, contact DSRSD Public Information (925-875-2282) to borrow all of the equipment and supplies needed to do this lesson. It is very helpful to have a parent or aide in the classroom to assist with this lesson.

Pre-class Preparation – Two Weeks Ahead

- ☐ Student worksheets, one per group
- ☐ Plastic cups (to hold "dirty water")
- ☐ Potting soil (to create "dirty water")
- ☐ Large plastic trays, one per group
- ☐ Two-liter clear plastic soda bottles, cut in half, one set per group
- ☐ Two rolls of paper towels for student clean-up
- ☐ Filtering materials (DSRSD will provide upon request)
    - Sand (OSH, Home depot)
    - Activated charcoal (aquarium stores)
    - Pea gravel (OSH, Home Depot)
    - Sponges, cut into 21/2" squares
    - Nylon stockings, cut into 3" squares (one pair yields 40-45 squares)
    - Cheesecloth, cut into 4" squares (grocery stores)
    - Rubber bands
    - Paper clips
    - Straws
    - Coffee filters
    - Yarn, cut into 18" length, must be white
    - Screen mesh, cut into 31/2' x 31/2" squares (OSH)
    - Napkins, white
    - Cotton balls
    - Duct tape
- ☐ Colorimeter (instructions are in plastic box with colorimeter)
- ☐ Colorimeter vials with caps, one per group plus one for blank
- ☐ De-ionized water for colorimeter blank