PHOTO CREDIT: © Landsat imagery courtesy of NASA Goddard Space Flight Center and U.S. Geological Survey

Money down the Drain

Who would pour money down the drain?

Grade Level
Upper Elementary, Middle School

Subject Areas
Environmental Science, Math

Duration
Preparation time: 30 minutes
Activity time: 50 minutes

Setting
Classroom, schoolyard

Skills
Gathering information (collecting, measuring, calculating); Interpreting (inferring, drawing conclusions)

Charting the Course
This introductory activity could be done in conjunction with "My Water Footprint." Processes and costs involved in delivering clean water to students' homes are addressed in "Reaching Your Limits" and "The Price Is Right." Activities incorporating water conservation such as "Water Audit" could follow this activity.

Vocabulary
conservation, municipal water system, plumbing systems, water pressure, washer

Summary
Through observation and simple calculations, students learn that a dripping faucet wastes a valuable resource.

Objectives
Students will:
- calculate the amount of water wasted by a dripping faucet.
- analyze the financial benefits of fixing leaking faucets.

Materials
Warm Up
- *A dripping faucet or a recording of dripping faucet* (optional)
- *A faucet washer* (optional)

The Activity
- *3 gallon-sized milk containers filled with 3 different colors of water.* (Put a small pin hole near the bottom of one jug, a slightly larger hole in the second using a thumbtack and a still larger hole using a nail in the last. Water should drip rather than stream from the holes. Cover the holes with tape until ready to begin the activity. Use more jugs for larger classes.)
- *Copies of* ***Money Down the Drain Worksheet*** *and* ***Answer Sheet***
- *6 stopwatches or cell phones with timers*
- *Containers to collect dripping water* (at least 1-gallon [3.8-l] capacity each)
- *A graduated cylinder*
- *Calculators* (optional)
- *A chart showing the local cost per unit of water used* (optional)

Making Connections
Unfortunately, leaking faucets are everywhere. Some students may even have one or more in their homes. Sometimes these are viewed as minor inconveniences rather than the loss of a resource, but the water (and money!) going down the drain is very real. Fixing a leaking faucet is a small, inexpensive, achievable task that can become a first step toward other water conservation measures.

PHOTO CREDIT: © Hemera–Thinkstock Photos

A leaky faucet can result in an expensive water bill.

Background

Plumbing systems are designed to efficiently supply water to and remove wastewater from homes. Pipes can develop leaks because of the age and quality of materials and construction of a plumbing system, water pressure and/or the chemical composition of water.

Sometimes large quantities of water can leak from a faucet or toilet over a day or week. A faucet that drips 160 drops per minute will lose more than 6 gallons (22.8 l) of water per day. If a faucet leaks a small stream of water, more than 25 gallons (95 l) of water per day may be lost down the drain!

Every drop of water leaking from a faucet is wasted water. To make up for this loss, municipal water supply systems are forced to treat more water to meet community needs. If a faucet is leaking 100 gallons (380 l) per day for 30 days, for example, 3,000 gallons (11,400 l) will be wasted. Homeowners also lose money through additional charges for water they are not actually using. If a water bill is $3.24 per thousand gallons (3,800 l) of water consumed (the average U.S. price according to the *2008 Water and Wastewater Rate Survey* conducted by the American Water Works Association), the leak will add $9.72 to the monthly bill for a total of $116.64 per year. (If the leaks occur in the hot water system, financial losses will be even greater, since the energy used to produce the heated water will also be wasted.) The price of a replacing a faucet washer, meanwhile, can be as little as one dollar—a considerable savings, even before energy costs for hot water are considered.

The loss of water to leaks extends to municipal water systems as well. Unfortunately, it is not uncommon for city water systems to lose as much as 10 to 20 percent of water through waterline leaks and breaks. Add business and home losses to those of the municipal system and it equals a lot of water—and money—down the drain.

Procedure

Warm Up

- Allow a faucet to leak during a class discussion. Place a container to catch the dripping water. At the end of the discussion or when students notice the dripping faucet, show students the collected water. Show the students a faucet washer and tell them the price (washer prices range from one to two dollars). Ask students to guess how much money could be saved by replacing a single faucet washer.
- Ask students how many of them know where they can find a leaking faucet. Have students share their views about leaking faucets. Do students notice them? Are they worth fixing?
- Pour collected water on plants.
  NOTE: If the classroom does not have a faucet, collect an hour's worth of dripping water from any faucet. You could record the sound of a dripping faucet and play it while you speak.

Hole in jug made by pin.

Hole in jug made by thumbtack.

Hole in jug made by nail.

PHOTO CREDIT: © Tony Simms | Dreamstime.com

Leaky infrastructure can waste a lot of water when trying to deliver it from one place to another.

The Activity

1. **Divide students into six groups. Assign two groups to each milk container and instruct them to complete the *Money Down the Drain* worksheet and the answer sheet for their container.**
2. **Arrange the three milk jugs on a table with collection buckets beneath them. Remove the tape and allow the dripping to begin.**
3. **After the worksheets are completed, have the two groups who worked on the same jug compare answers. Instruct the groups to share data and complete information about the other two jugs. Compare results.**

Wrap Up

- Ask students what they thought about the amount of water wasted by the drips. Do they think the amount of money lost was significant? Would they rather have used the money lost down the drain to buy something else? Ask students to list reasons why leaking faucets should be fixed.
- Have students calculate how much water is lost from dripping faucets around their home or at school. Ask them to research how to fix leaking faucets or ask a plumber to demonstrate how easily a faucet can be fixed.
- Have students create posters presenting facts about leaking faucets. City Hall, a grocery store or the library may post the information.

Project WET Reading Corner

Goodman, Donna L. 2003. *Every Body Counts, Every Drop Matters*. New York, NY: United Nations Department of Public Information.
Learn fun and interesting ways to conserve water.

Green, Jen. 2005. *Why Should I Save Water?* New York, NY: Barron's Educational Series.
Children will learn about water, our most precious resource, and how to avoid wasting it.

Project WET Foundation. 2001. *Conserve Water*. Bozeman, MT: Project WET Foundation.
Children's illustrated activity booklet on water conservation.

Project WET Foundation. 2004. *Water Every Drop Counts*. Bozeman, MT: Project WET Foundation.
Children's illustrated activity booklet that discusses why water is so precious.

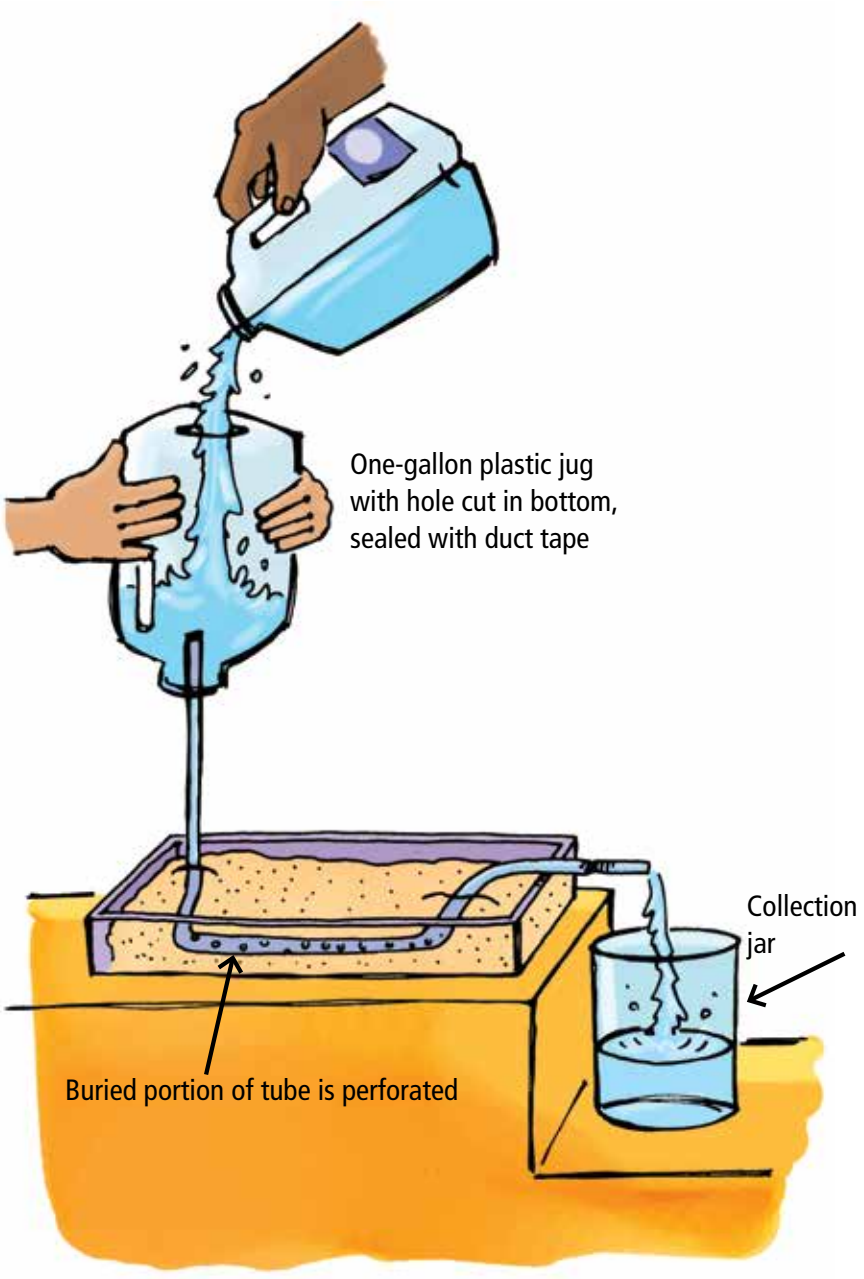
Assessment

Have students:

- calculate how much water is lost from dripping faucets (step 2).
- identify financial reasons why leaking faucets should be fixed (step 3 and ***Wrap Up***).

Extensions

The following demonstration illustrates how extra water supply is needed when leaks are present. Poke holes or cut slices in a small section of a flexible water hose or surgical tubing. Bury the punctured part of the tube under some sand in a shallow pan. Cut a hole in the bottom of a plastic gallon (3.8 l) jug, attach the mouth of the jug to the top portion of the tube and seal with duct tape. Constrict the tube a few inches (cm) from where it empties into the container. This creates pressure that exists in water systems, exacerbating water loss in leaking pipes. Measure one gallon (3.8 l) of water and pour into the inverted jug. Collect the water as it comes out the other end of the tube. Do not tell students about the holes or slices in the tube. Ask students how much water they think will pour out the other end of the tube. The end result should be less than one gallon because some is lost through the leaks. Discuss how this often occurs in city water systems. Have students identify what would ensure that a gallon of water reaches the other end—pouring more water into the jug! Tell students that the water lines of many communities are over 100 years old and that the materials have corroded with age. Unchecked leaks will waste water over many years and in the process cost the water user money. However, underground leaks are expensive to fix because they often require extensive excavations. When designing a water system, project planners will calculate a 10 to 20 percent water loss factor to adjust for unaccountable losses (leaks). This means that a water system must supply 10 to 20 percent more water to a community than needed, to ensure people will have enough water.



Challenge students to deliver water from a source to a destination—with containers with a variety of leak "intensities." Create six groups: The first group's container should have no leak, while the final group's should have a major leak. The four groups in the middle should have a leakage level in between. Give groups the task of filling buckets some 50 feet away. As students transport their water, they will learn that it takes significantly more water to meet their needs when a percentage is lost in delivery.

Take a field trip to a local water utility. Have a person at the utility talk about water treatment, its cost and the problem of municipal water leaks. Have students compare the amount of water leaked during the activity to the amount of water stored in the municipal water tower or storage reservoir.

Teacher Resources

Books

The Watercourse and Project WET Foundation. 2000. *Conserve Water: Educators Guide.* Bozeman, MT: The Watercourse.

Journals

Farenga, Stephen J., Beverly A. Joyce and Daniel Ness. 2004. "Drop by Drop, Liter by Liter." *Science Scope, 27 (8), 42-44.*

Smith, Michael J. and John B. Southard. 2002. "Water Is All around You." *Science Scope*, 26 (2), 32-35.

Stokes, Nina Christiane and Mary Margaret Hull. 2002. "Every Drop Counts: Students Develop Public Service Announcements on the Importance of Water Conservation." *Science Teacher*, 69 (5), 40-41.

Websites

American Water Works Institute. 2008. *Water and Wastewater Rate Survey*. The most comprehensive survey of water and wastewater utility rates, available for purchase on the site. http://apps.awwa.org/EbusMain/Default.aspx?TabID=55&ProductId=20743. Accessed May 25, 2011.

United States Environmental Protection Agency. *Water Sense*. Resource site for water usage and conservation ideas and activities. www.epa.gov/WaterSense/. Accessed December 15, 2010.

Answer sheet for Jug # _____

Name: _____

Date: _____

Record answers to questions 1 and 2 below.

	1. Drops per minute			2. Volume of water (ml) collected in 1 minute		
	JUG #1	JUG #2	JUG #3	JUG #1	JUG #2	JUG #3
Reading #1						
Reading #2						
Reading #3						
Total						
Average (Total ÷ 3)						

Record answers to questions 3, 4, 5, 7, 8, 9, 10 and 11 below. Write answer to question 6 below or on another page.

	JUG #1	JUG #2	JUG #3
3. estimate			
4. jug empty			
5. actual time			
7. ml/hour			
8. ml/day			
9. ml/week			
10. ml/month			
11. $/month			

Name: _____

Date: _____

INSTRUCTIONS: Complete the information for your jug, then meet with other groups to fill in the rest of the data. (NOTE: for simplicity, all measurements are in the metric system.)

Observe the water dripping from the jug and answer the following questions. Record your responses on the answer sheet.

1. How many drops fall each minute? (Take three readings and find the average. Skip this question and the next if there is a small stream instead of drips.)

   Reading 1:_____ drops Reading 3:_____ drops

   Reading 2:_____ drops

   Add the above readings and divide by 3 to find the average:

   Reading 1_____drops + Reading 2_____drops +

   Reading 3_____drops =_____

   Total drops ÷ 3 = _____average drops per minute

2. How much water drips from the jug in a minute? (Collect one minute's worth of water and measure the volume in a graduated cylinder. Take three readings and find the average.)

   Reading 1:_____ ml Reading 3:_____ ml

   Reading 2:_____ ml

   Add the above readings and divide by 3 to find the average:

   Reading 1_____ ml + Reading 2 _____ml +

   Reading 3_____ ml = _____

   Total ml ÷ 3 = _____ average ml per minute

3. Estimate how much time it will take the jug to empty: _____

4. Calculate the time it will take the jug to empty. (NOTE: One gallon of water equals 3,785 ml.)

   3,785 ml per gallon ÷ average amount of water collected in one minute = minutes for jug to empty:

   3,785 ml per gallon ÷ _____ ml per minute =

   _____ minutes for jug to empty

5. Time how long it takes for the jug to actually empty (optional). (NOTE: reduced pressure as water level goes down may cause some jugs not to empty completely. Do not shake or squeeze jug, stop timing after the last drop naturally falls): _____

6. How do the answers to 3, 4 and 5 compare to each other? Write the reasons why they are similar or different (see note in number 5 for suggestions).

7. If this was a faucet leaking this much water, how much water would be lost in one hour?

   Average amount of water collected in one minute x 60 minutes = ml per hour:

   _____ ml per minute x 60 minutes = _____ ml per hour

8. How much water would be lost in one day?

   ml per hour x 24 hours = ml per day:

   _____ ml per hour X 24 hours = _____ ml per day

9. How much water would be lost in one week?

   ml per day x 7 days = ml per week:

   _____ ml per day x 7 days = _____ ml per week

10. How much water would be lost in one month? (For simplicity, assume 1 month equals exactly 4 weeks.)

    ml per week x 4 weeks = ml per month:

    _____ ml per week x 4 weeks = _____ ml per month

11. Many people have to pay for their water. If water costs $10 for every 200 ft3* (200 ft3 equals 5,663,369 ml) and if the water dripping from the jug was a real faucet, how much would a person pay each month for this water down the drain?

    _____ ml per month x ($10 ÷ 5,663,369 ml) =

    $ _____ per month

**Replace value with actual cost of water for your community, if known.*