

National Science Content Standards:

A: Science as Inquiry

F: Science in personal & social perspectives

National Math Content Standards:

Measurement

Problem Solving

OBJECTIVE:

To measure personal water-usage and calculate an individual "water footprint." To promote an awareness of daily water use. To teach students how to collect quantitative data and calculate finite measurements using estimations. To introduce the concept of unequal distribution of water and volume of water consumed around the world, and encourage a relevant discussion about this comparison. To encourage students to identify daily water conservation strategies.

MATERIALS:

- Table 1. Water Consumed During Daily Activities
- Table 2. Water Used to Produce Food Products
- Table 3. World Water Use

BACKGROUND:

Most people in the developed world don't think much about fresh water. We turn on the faucet and there it is; clean, drinkable water. But as populations grow and the amount of water on earth stays the same, there is more pressure on our rivers, reservoirs and groundwater resources. Much of the freshwater usage in the world is for agriculture; irrigation of crops for humans and livestock.¹ In North America, a lot of our water goes to industry to produce the goods that we use on a regular basis like paper, plastic and materials used for our shoes and clothing.² Although we cannot personally control the amount of water used to grow our food or power our industries, we can carefully consider our food choices and product selections in terms of how much water they require to grow or manufacture. We can also exert control over our own personal water use, and maybe even impact the water-use of our families and friends. Practicing water conservation is a way to protect our natural water resources. We can also help educate others about good water-use habits and choices.

PROCEDURE:

Discuss with students how humans use water:

- Discuss water in food production: <http://ga.water.usgs.gov/edu/sc1.html> [Table 2.]
- Investigate and discuss how humans use water by industry:
<http://ga.water.usgs.gov/edu/wateruse.html>



- Discuss water as a requirement for daily living:

Ask students to think of the water-using activities they do every day (take a shower, brush teeth, flush the toilet, wash dishes, fill their pet's water bowl or bottle).

What are the first three things students do when they get up in the morning? Do these activities use water?

Introduce how to measure water usage:

- Review the basic measurements of liquid volume - space occupied by a liquid expressed in ounces, liters or gallons. Use the liter of water and the gallons of water as visual aids.

1 gallon = 3.8 liters; 1 liter = 0.264 gallons

- Discuss with students how the measurement of water-use in one day is expressed as **per-capita** water consumption (*per* is Latin for *by* and *capita* is Latin for *head*). The number is usually expressed as **gallons of water used per person per day**.

Drip Math:

Discuss ways in which people waste water:

- Introduce the following word problem for students to solve. Older students with more advanced math skills may attempt to solve the problem on their own, and then share their methods and answers with the class. Younger students will need assistance; work together as a group to solve the problem.
- **Calculate how many liters and gallons of water are wasted in 1 week by a sink that drips or leaks 1 drop per second.** (*See units of measure below*)

1 drop = 1/20 th of a milliliter	1 liter of water = 20,000 drops	1 liter = 0.264 gallons
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- First calculate the number of drips in a day:

60 seconds = 1 minute

60 minutes (1 hour) = 3,600 seconds

24 hours in a day x 3,600 seconds = 86,400 seconds per day

Since it is ONE drop per second, there are 86,400 drips per day.

- Now determine the number of drips per week:

7 days per week X 86,400 drips per day = 604,800 drips per week. Next determine the total number of liters wasted per week in drips: 604,800/20,000 = 30.24 liters

- Finally, determine the number of gallons wasted per week:

30.24 liters x 0.264 (gallons per liter) = 7.98 (or almost 8) gallons per week!

- As an extension: students may calculate how many liters and gallons per month and per year are wasted by a dripping faucet.

How much water does it take to ...

- Have students hypothesize how much water is needed to perform various daily activities, such as flushing a toilet, running a dishwasher, washing dishes, watering a lawn, taking a shower, taking a bath, washing clothes, brushing teeth, washing a car. (See Table 1 for answers.)

- Share with students that on average, each person in the US uses 140 gallons of water per day in a home. See Table 3 below, World Water Use. Compare US average daily usage per person to daily usage in other countries. Which countries' daily water usage amounts were surprising? Why? Students can brainstorm the reasons for inequity between countries' water usage.
- Show students the following EPA water usage table with the values hidden (as a handout sheet or PowerPoint slide with on click animation).

Personal Water Audit:

- Explain to students that for the next week they and their families will gather data and keep daily logs of their home (domestic) water usage. Where they are unable to collect all the information they and their family may estimate usage for the missing information. **Download** the activity and review the instructions with the class: <http://www.ciese.org/curriculum/drainproj/instructions/>.
- Download and print the **Personal Water Use Chart** using one of the linked files in the activity: <http://www.ciese.org/curriculum/drainproj/personalwateruse/>. This chart is available to be downloaded as an excel spreadsheet (complete with formulas), which can be used to tabulate results or used in spreadsheet form on a computer to automatically calculate results. Follow directions in the activity for completion.

WRAP-UP:

- Ask students to identify which category comprised the greatest portion of their water use. What surprised them most about their results? What behavioral changes can they make that will have the greatest impact on their daily usage? What suggestions do they have to help others make these same or other changes? Older students might also make pie charts of their usage.
- Use the EPA Water Pollution Prevention and Conservation handout for some ideas to pass onto students: <http://www.epa.gov/p2/pubs/water.htm>. Have students explore the USGS site and compare their findings with the drip calculator provided: <http://ga.water.usgs.gov/edu/sq3.html>.
- How accurate were their calculations? Discuss what they can do to reduce water waste **in their school**. (Report leaks to parents and school staff, monitor for completion of repairs, get out the word about stopping water waste, get community support for their campaigns, etc.) See the linked article for suggestions of how to "go green" with your water: <http://www.treehugger.com/htgg/how-to-go-green-water.html#tips>.

EXTENSION:

- Have students create a hypothetical day of food intake for three meals and snacks based upon a menu from the items in Table 2. Water Used to Produce Some Common Food Items.
- Estimate the amount of water used that day based on the water footprints listed. Explore a variety of food choices on the following interactive site: <http://www.waterfootprint.org/?page=files/productgallery>.
- Discuss how food choices can significantly impact your water footprint. Which choices use the least amount of water? Which selections require the most amount of water?
- **OPTIONAL ONLINE WATER CALCULATOR:** Use an online water footprint calculator to automatically calculate personal water footprints: http://www.h2oconserve.org/?page_id=503

ENDNOTES:

¹AQUASTAT, FAO's Information System on Water and Agriculture; Food and Agriculture Organization of the United Nations, http://www.fao.org/nr/water/aquastat/water_use/index.stm

²Commission for Environmental Cooperation; The North American Mosaic: An Overview of Key Environmental Issues. p.2 (http://www.cec.org/Storage/32/2366_SOE_WaterQuantity_en.pdf)

Table 1. Water Consumed During Daily Activities

Activity:	Water Consumed:
Flush a toilet	5-7 gallons
Run a dishwasher	15-25 gallons
Wash dishes by hand	20 gallons
Water a small lawn	35 gallons
Take a shower	25-50 gallons
Take a bath	50 gallons
Wash a load of clothes in a washing machine	35 gallons
Brush teeth (with water running continuously)	2-5 gallons
Wash a car	Approximately 20 liters per minute

Table 2. Water Used to Produce Some Common Food Items

Food Items:	Water Needed for Production:
Glass of milk	200 L
Slice of bread	40 L
Slice of bread with cheese	90 L
1 potato	25 L
1 bag of potato chips	185 L
1 apple	70 L
1 tomato	13 L
1 glass of apple juice	190
1 egg	135 L
1 hamburger	2400 L
Paper	3 gal/sheet of paper
Pork	575 gal/pound
Potato	108 gal/pound
Rice	407 gal/pound
Sugar	180 gal/pound
Tea	8 gal/cup
1 peanut butter cup	2,847 gallons

Adapted from: UNESCO-IHE Institute for Water Education:

<http://www.waterfootprint.org/Reports/Report16Vol1.pdf>

For visual walk-through of the above food items go to: <http://www.waterfootprint.org/?page=files/productgallery>

Table 3. World Water Use

Continent / Country:	Domestic Water Use (Gallons per person per day):
Africa	
Ethiopia	3
Kenya	8
South Africa	56
Europe	
Germany	41
Sweden	77
United Kingdom	30
North America	
Canada	188
Mexico	73
United States	140
Central America	
Haiti	3
Dominican Republic	76
Guatemala	7
South America	
Brazil	60
Columbia	84
Venezuela	12
Asia	
China	38
India	33
Japan	99

Source: "The World's Water; Volume 7. 2010." <http://www.worldwater.org/data.html>