Lesson Plan (grades 5-8): Water Conservation and Dietary Connections
A science-math lesson in three steps with daily log and activity sheets, sample calculations, and discussion Q&A included

Grade Level and Subjects: Grades **5-8** science, math, social studies, health

Length: 1-2 class periods

Purposes:
- To calculate total daily water consumption and average daily water consumption including both direct and indirect uses.
- To compare and contrast students' water use.
- To graphically represent data in tables and histograms.
- To correlate water use and dietary choices.

Objectives: As a result of this lesson's activities, students will be able to:
- identify direct and indirect ways that people consume water on a daily basis.
- calculate daily averages of personal water use based on established reference values.
- display data in tabular and histographic form.
- make cross-comparisons concerning water usage in terms of dietary choices.
- propose ways to mitigate water consumption on personal, national, and global levels.

National Science Content Standards* Correspondence:

NS.5-8.1 *Science as Inquiry* As a result of activities in grades 5-8, all students should develop
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

NS.5-8.3 *Life Science* As a result of their activities in grades 5-8, all students should develop understanding of
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

NS.5-8.5 *Science and Technology* As a result of activities in grades 5-8, all students should develop
- Abilities of technological design
- Understandings about science and technology

NS.5-8.6 *Personal and Social Perspectives* As a result of activities in grades 5-8, all students should develop understanding of
- Personal health
- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

National Mathematics Content Standards Correspondence:*

Measurement Standard for Grades 6-8:
In grades 6-8, all students should
- understand measurable attributes of objects and the units, systems, and processes of measurement.

Data Analysis and Probability Standard for Grades 6-8:
In grades 6-8, all students should
- formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
- collect data using observations, surveys, and experiments.
- select and use appropriate statistical methods to analyze data.
- develop and evaluate inferences and predictions that are based on data.

Problem Solving Standard for Grades 6-8:
In grades 6-8, all students should
- solve problems that arise in mathematics and in other contexts.
- apply and adapt a variety of appropriate strategies to solve problems.

Representation Standard for Grades 6-8:
In grades 6-8, all students should
- relate and use representations to organize, record, and communicate mathematical ideas.
- select, apply, and translate among mathematical representations to solve problems.
- use representations to model and interpret physical, social, and mathematical phenomena.

*Education World (2008) *U.S. National Education Standards*. Retrieved September 18th, 2009 http://www.education-world.com/standards/national/index.shtml

Materials Needed:
- whiteboard and markers, overhead projector, or Smart Board
- empty containers, stopwatch

Prior Knowledge and Skills Needed:
- Water as a requirement in food production
- Water as a requirement in daily living
- Reading information from tables
- Measuring volume quantities
- Converting between metric and English units of volume (as needed)
- Making predictions
- Collecting data
- Calculating averages
- Arranging data into tabular and histographic form

Assessment:
Students will be assessed through these means:
- Successful completion of a daily log
- Successful completion of student activity sheets
- Participation in oral presentation of results

Vocabulary:
- **natural resource:** an economically valuable, naturally occurring material (e.g., timber, oil, minerals, water)
- **water conservation:** the preservation and careful management of water

- **water pollutant:** a contaminant of waterbodies that renders them harmful to animals, plants, and/or humans (e.g., animal manure, motor oil, etc.)
- **liquid volume:** quantity of three-dimensional space occupied by a liquid, expressed in liters, ounces, or some similar unit
- **conversion factors:** 1 L= 39 ounces; 1 gallon = 3.8 L; 1 L (approximately one quart) equals 1,000 milliliters (ml); 4 quarts = one gallon; 1 lb. = 16 oz.; 1 lb. equals 454 grams; 1 kilogram = 2.2 lbs.

Lesson Background:
Teachers may look at the United Nations' 2006 report titled *Livestock's Long Shadow* available at http://www.fao.org/docrep/010/a0701e/a0701e00.htm Chapter IV deals with water pollution due to animal agriculture. Both national and global issues are discussed. The major conclusion of this Report is that livestock production is a leading source of environmental damage including climate change; water and air pollution; land degradation; and loss of biodiversity. The Report suggests that a human diet that is plant-based would prevent much of the environmental damage caused by animal agriculture, including the feedcrop production associated with it.

Please see the section titled *Water Facts* (below) for tabular information and other relevant statistics involving direct and indirect personal water use.

Procedure:
NOTE: The students need to keep a daily log of their water usage for approximately seven days. Calculating the daily water use of friends or family members with different dietary preferences (e.g., vegetarian or vegan) for comparison purposes may contribute added insight.

Lesson Step #1: Introduction and Topic Setting
The teacher introduces the subject by role playing a "water waster" by letting the water run in the classroom, cafeteria, and/or bathroom. Teacher leads a general discussion to determine how much students know about the quantity of water needed to perform common daily activities (e.g., flush a toilet). Showing the EPA table (Table 1 below) of common values may be instructive. Teacher may ask how someone can conserve water in daily living. To lead into the activity, teacher proposes that food choices also can be responsible for water wastage in an indirect way. Showing Tables 2 and 3 (below) will be helpful at this point. Students may conclude that purchasers of these foods are indirectly responsible for the water use and/or pollution.

Lesson Step #2: *Activity: Daily Log of Personal Water Usage and Sample Determination*
1. Students discuss daily log sheets with teacher and among themselves. All obvious water uses need to be calculated (toilet flushing, brushing teeth, taking showers, etc.) as well as the not so obvious uses: water used for growing food, preparing food, etc.

2. Students discuss ways to determine flow rates of showers, toilets, etc. This may be accomplished by looking through manufacturer materials or websites, contacting manufacturers, or doing a calculation. Calculations may be done using a watch and large empty containers. The amount of water collected per minute may be determined. Students should be advised to standardize the flow rates used over all the days of data collection or told about the necessity of recalculating them each time. For cooking, personal quantities may be calculated by dividing the total amount of water used to cook a food item by the number of people eating the meals consumed. Similar calculations would be done for clothes and dish washing. Alternatively, one can estimate the quantity eaten/consumed.

3. Students determine amount of water collected in a given time frame from a classroom, bathroom, or kitchen sink as an example using empty containers and a stopwatch.

4. At the end of the predetermined data collection time period, students assemble all data into a class histogram. See sample below.

Lesson Step #3: Culminating activity: Students present to everyone what their average daily use of water was. Students display their histograms. Students summarize conclusions drawn based on questions from the lab sheet.

Water Facts:

Table 1. Water Consumed during Daily Activities (data taken from EPA website http://www.epa.gov/reg5rcra/wptdiv/p2pages/water.pdf)

Activity	**Water consumed (gallons)**
Flush toilet	5-7
Run dishwasher	15-25
Wash dishes by hand	20
Water a small lawn	35
Take a shower	25-50
Take a bath	50
Wash a small load in a washing machine	35
Brush teeth with water running	2-5

U.S. and Global Daily Water Intakes
Chapter Four of *Livestock's Long Shadow* cites sources that on average, people consume 30-300 L of water per day for household uses while 3,000 L of water are used to grow their daily food.

David and Marcia Pimentel, authors of *Food, Energy, and Society, 3rd ed.* (2008), cite sources that Americans average 400 L water/person/day. They point out that in eighty-three other countries, the average daily water use per person is below 100 L. In the U.S., daily freshwater withdrawals of surface and groundwater used mainly for irrigation of crops for humans and livestock are 5,700 L per person. Worldwide, the average daily value of water for food production is 1, 970 L/person.

Table 2. Estimated Amount of Water Used to Produce Crops and Livestock in the U.S. (Liter/kilogram)
(Note: One liter is approximately the same as one quart. One kilogram is approximately the same as 2.2 lbs.)

Food Item	**Hoekstra &**

	Chapagain (L/kg)
Corn	500
Wheat	850
Soybeans	1,900
Rice	1,600
Cow's milk	700
Eggs	1,500
Beef (feedlot)	13,000
Pork	3,900
Poultry	2,400

Note: *Values taken from Chapagain A, Hoekstra A (2004*) Water Footprints of Nations Volume One: Main Report. *Value of Water Research Report Series No.16. Delft (The Netherlands): UNESCO – IHE Institute for Water Education.* http://www.waterfootprint.org/Reports/Report16Vol1.pdf

Table 3. Water Used to Produce Some Common Items
(Note: One liter (approximately one quart) equals 1,000 milliliters (ml). One pound equals 454 g.)

Food Item	Water Needed for Production (L)
1 cup of coffee (125 ml)	140
1 glass of milk (200 ml)	200
1 slice of bread (30 g)	40
1 slice of bread (30 g) with cheese (10 g)	90
1 potato (100 g)	25
1 bag of potato chips (200 g)	185
1 apple (100 g)	70
1 tomato (70 g)	13
1 glass of apple juice (200 ml)	190
1 egg (40 g)	135
1 hamburger (150 g)	2400
Dry pasta (made in Italy;1 kg)*	1900
Cheese pizza (made in Italy; 725 g)*	1200 (or 248 L per 150 g = ~1/4 pizza)
Tomato pizza (made in Italy; 600 g)*	300 (or 75 L per 150 g = ~1/4 pizza)

Note: Values taken from Chapagain A, Hoekstra A (2004) Water Footprints of Nations Volume One: Main Report. *Value of Water Research Report Series No.16. Delft (The Netherlands): UNESCO – IHE Institute for Water Education.* http://www.waterfootprint.org/Reports/Report16Vol1.pdf
Asterisked values taken from Aldaya M, Hoekstra A. (2009) The Water Needed to Have Italians Eat Pasta and Pizza. *Value of Water Research Report Series No.36. Delft (The Netherlands): UNESCO – IHE Institute for Water Education.* http://www.waterfootprint.org/Reports/Report36-WaterFootprint-Pasta-Pizza.pdf

RESOURCES:

1. Educational materials, teacher's guides, lesson plans, and student pages

http://www.earthday.net

There are several categories of well-developed environmental lesson plans for all grade levels. Topics include climate, sustainability, and organics and food. Site has an environmental jeopardy game that students will enjoy.

http://www.ec.gc.ca/water/en/info/pubs/lntwfg/e_contnt.htm
Environment Canada, analogous to the EPA of the U.S., has a thorough unit study on water that ranges across the curriculum, complete with activities and assessments of all types.

http://eelink.net/pages/Lesson+Plans
The North American Association for Environmental Education (NAAEE) has a multitude of lesson plans, teacher guides, and student resources at its site.

http://www.epa.gov/kids/
This site is written to appeal to children of all ages. There are many interactive features and many downloadable resources. With art, game, and science rooms, as well as pages devoted to environmental issues of all types, this site could make a good supplemental resource or lesson enhancement.

http://www.footprintnetwork.org
Provides an interactive quiz that students will enjoy to calculate the ecological footprint of cities, businesses, and individuals.

http://kids.niehs.nih.gov/
National Institute of Environmental Health Sciences (NIEHS) has an enormous website filled with useful resources for teachers and students in all grade levels. Certain pages are written at a child's level and cover many different topics related to environmental health.

http://www.unep.org/tunza/children/
The United Nations Environment Programme has a website just for young people of all ages. There are story time videos created by UNEP, youth environmental action updates, competitions, and events among many other pages.

http://www.unesco.org/water/wwap/
The World Water Assessment Programme, a division of UNESCO, provides facts and figures on global water issues. The organization publishes many documents, including the United Nations World Water Development Reports, that serve as good references for educators in many subject areas and excellent source information for student projects.

http://www.waterfootprint.org/?page=files/WaterFootprintCalculator
Quick and extended individual water footprint calculators are available on this website. The publications page of UNESCO-IHE's Institute for Water Education contains many reports and articles of interest.

2. Water non-profit organizations
These groups offer many fundraising ideas and opportunities for a socially-motivated student, class, or school.

http://www.charitywater.org/

http://www.cleanwateraction.org/

http://www.ryanswell.ca/
First grader Ryan Hreljac was inspired by a classroom lesson about children who don't have clean water around the world and began raising money to provide it. Over ten years later, his Ryan's Well Foundation is still very active. At this site, children and youth can learn about fundraising projects and ways to get involved so that everyone in the world can have clean water.

http://thewaterproject.org

http://www.waterforpeople.org

Water Conservation and Dietary Connections

Activity Sheet GRADES 5-8

Name _____ **Date** _____

Directions: Determine the quantity of water used to perform each activity. You may need to research flow rates for a certain shower head, toilet, etc., contact the manufacturer, or perform a sample calculation yourself like the one done in class. Fill in any other activities using water on the blank lines.

Activity	**Volume of water used (gallons)**
Flush a toilet once at home	
Flush a toilet once at school	
Flush a toilet once at _____	
Flush a toilet once at _____	
Flush a toilet once at _____	
Take a shower at _____	
Take a shower at _____	
Take a bath at _____	
Take a bath at _____	
Brush teeth at _____	
Brush teeth at _____	
Brush teeth at _____	
Run a dishwasher at _____	
Run a dishwater at _____	
Wash a load of clothes (small)	
Wash a load of clothes (large)	
Wash dishes by hand at _____	
Wash dishes by hand at _____	

Water Conservation and Dietary Connections

Activity Sheet GRADES 5-8

DAILY ACTIVITY LOG

Name _____ **Date** _____

Directions: Record the number of times you have performed the following activities per day. Repeat for the determined time period for our class: _____days/weeks. Using tally marks may be helpful.

Activity	Number of times performed per day
Flush a toilet once at school	
Flush a toilet once at _____	
Flush a toilet once at _____	
Flush a toilet once at _____	
Take a shower at _____	
Take a shower at _____	
Take a bath at _____	
Take a bath at _____	
Brush teeth at _____	
Brush teeth at _____	
Brush teeth at _____	
Run a dishwasher at _____	
Run a dishwater at _____	
Wash a load of clothes (small)	
Wash a load of clothes (large)	
Wash dishes by hand at _____	
Wash dishes by hand at _____	

Water Conservation and Dietary Connections

Activity Sheet GRADES 5-8

DAILY FOOD LOG

Name _____ **Date** _____

Directions: Record the foods and beverages consumed each day. Approximate quantities as best as you can. Repeat for the determined time period for our class: _____days/weeks.

Food or beverage consumed	Quantity (oz., liters, pounds, kilograms, etc.)

Water Conservation and Dietary Connections

Sample Calculation Sheet GRADES 5-8

Name _____ **Date** _____

Directions: For doing a class histogram, everyone's measurements must be expressed using the same units. All of your values must be expressed in GALLONS for the activities performed. All food or beverage values must be expressed in KILOGRAMS or LITERS. Using these units allows for easy comparison with the tables of reference.

Conversions: 1 liter (L)= 39 ounces (oz.); 1 gallon = 3.8 L; 1 L (approximately one quart) equals 1,000 milliliters (ml); 4 quarts = one gallon; 1 pound (lb.) = 16 oz.; 1 lb. = 454 grams (g); 1 kilogram (kg) = 2.2 lbs.

1. Express what an 8 oz. glass of juice is in liters.

2. Express what a 125 ml of tea is in liters.

3. Express what a 100-gram apple weighs in kilograms.

4. Express what a 4 oz. hamburger weighs in kilograms.

5. Express what quantity of water results from a ten-minute shower with a flow rate of 3 gallons/minute.

6. Express what quantity of water in gallons is used from flushing a toilet that uses 30 liters of water each time.

ANSWERS:

1. 8 oz. x 1 L/39 oz. = 0.2 L of juice

2. 125 ml x 1 l/1,000 ml = 0.125 L of tea

3. 100 g x 1 kg/1000 g = 0.100 kg apple

4. 4 oz. x 1 lb./16 oz. = 0.25 lb.

0.25 lb. x 1 kg/2.2 lbs. = 0.11 kg of hamburger

5. 10 min. x 3 gallons/minute = 30 gallons of water

6. 30 L x 1 gallon/ 4 L = 7.5 gallons

Water Conservation and Dietary Connections

DISCUSSION QUESTIONS

GRADES 5-8

Name _____ Date _____

1. Estimate how easy or difficult it was to do this activity. Explain your reasons. List as many possible sources of error as you can.

2. Looking at the values from people eating a meat-based diet and those eating a vegetarian, vegan, or plant-based diet without much meat, what can you conclude about water usage and dietary connections? Explain your answer using specific data.

Answers:

1. Answers will vary. Some possible points: difficult to use the same shower or sink flow rate every time; may use a toilet or sink for which the water usage was not previously determined; not everyone eats equal quantities of a meal made for several people; can't weigh out every item eaten; conversion factors are only approximate; etc.

2. Answers will vary. Some important points: Most of the water usage of an individual on a daily basis is due to food consumed. This is an indirect use that is easily overlooked but very significant. It takes significant quantities of water to produce meat as compared to grains, beans, vegetables, and fruits. A diet high in the latter items requires a lot less water to produce. "Eating lower on the food chain" is wise in terms of water conservation. Regarding the water facts presented in this lesson, Americans have higher values than the global averages because most people in the world (other than in developed countries) subsist largely on diets containing little meat.

Sample histogram

http://www.ncl.ucar.edu/Applications/histo.shtml

There are several possibilities for histograms in this activity. A class could do one with number of gallons on the y-axis and a bar with each person's name under it on the x-axis to show the average daily water usage. Or, each person could do one for herself using Day #1, Day #2, etc. on the x-axis and gallons on the y-axis. Similar ones could be done just on diet. A composite histogram including values for both activities and diet could be made.