

THE WATER YOU USE

Overview

Students will conduct a survey of their total water use in a 24 hour period. They will organize, simplify, and communicate their findings, using tallies, frequency tables, and histograms. Then students will determine the volume of water used by their class over the twenty-four-hour period, and examine the behaviors they might change to conserve water.

Subjects: Science, Math, Social Studies

Group Size: teams of four students

Estimated Teaching Time: 10 minute introduction, homework, two hours for data reduction and analysis

Curriculum Framework: IA, IIIB1, IIIB2, IIIB3, VA, VB, VC, VIA, VIC

Environmental Education Framework: Goals IIIA, IVB, VA

Vocabulary: conservation, data, frequency, histogram, per capita, tally, volume

Objectives

Students will:

- keep track of their personal water use for 24 hours.
- tally water use data, determine frequency of use, and construct histograms based on the frequency of water use of their class.
- calculate volume of water used and construct histograms based on volume of water used by their class.
- examine their water usage identifying practices that could be changed to conserve water.

Background

Daily water use varies greatly across the Valley of the Sun. The following chart lists daily residential water consumption averaged across a year, (1992) in various municipalities. In the United States, measurements are usually reported in gallons per capita per day (GPCD). Metric equivalents are also provided here to help teachers whose curricular goals include student understanding of both English and Metric Systems of measurement. One gallon is approximately equal to 3.785 liters. One liter equals about .264 gallons.

Of course, we use more water during summer especially for outdoor watering of plants, filling swimming pools, and operating evaporative coolers. Summer water use is nearly double that used in and around homes during winter. Residential water use is affected by weather, type of housing, the number of people in the home, the conservation methods practiced inside and outside, and the resident's schedules. It

CITY	1992 RESIDENTIAL GPCD (GALLONS PER CAPITA PER DAY)	1992 RESIDENTIAL LITERS (PER CAPITA PER DAY)	1992 NON- RESIDENTIAL GPCD	1992 NON- RESIDENTIAL LITERS (PER CAPITA PER DAY)
Chandler	136	515	73	276
Gilbert	150	568	49	185
Glendale	147	556	52	197
Goodyear	93	352	142	537
Mesa	138	522	48	182
Paradise Valley	533	2017	251	950
Peoria	140	530	45	170
Phoenix	154	582	71	269
Scottsdale	206	780	96	363
Tempe	114	431	137	519

Source: Arizona Department of Water Resources, October 1993.

is likely less water would be used in a home with low-flow devices and a xeriscape landscape design and where all residents were at work and school all day than in a home where the residents were always home and followed no water-wise practices.

Although per capita interior water use does not vary greatly based on the type of housing, per capita exterior water use is usually lower for multi-family housing where the outdoor areas are shared by many people and, thus, there is less landscaped area per person. This may help explain the large water usage in the Paradise Valley area where more single-family homes are found, and where the minimum lot size is 1 acre. The low water usage in Goodyear might be explained by smaller lot size for homes. In addition, many Goodyear homes were built after 1980 when new construction was required to use low-water-use plumbing. Another possible explanation for the wide ranging GPCD rates is the way GPCD is calculated. Per capita is based on the number of residents counted by the census. This number does not include winter residents (who may spend five or six months of each year in the Phoenix area). Goodyear's occupancy rate is 94%; whereas, Paradise Valley has only a 79% occupancy rate indicating a much higher percentage of "snow-birds."

In this activity students will gather data from a survey of their own water use and use three different ways of communicating the findings of that use. They will then transfer the frequency of uses to decide volume of water used, and identify some lifestyle changes they could make to reduce per capita water use. The most important understandings students should have because of this activity are that they are water users and they have the power to change their behaviors to conserve water.

Materials

- TALLY AND FREQUENCY CHART, one overhead transparency for the class
- PERSONAL WATER USE SHEET, one per student and teacher (Teacher does survey, too, and shares results with students.)
- overhead projector and pens

For each team of four students:

- TALLY AND FREQUENCY CHART
- HISTOGRAMS: TOP FIVE WATER USERS
- AVERAGE WATER VOLUMES FOR TYPICAL ACTIVITIES
- calculator
- colored pencils or markers

Communication of information through tables and graphs is an important skill. The applied mathematics methods the students will use to display their data include tallies, frequency tables, and histograms. A **tally** is a mark made for each observation that falls within a category. A **frequency table** is made when tally marks are counted; data are represented as whole numbers instead of lines that must be counted. A **histogram** is a bar graph in which the length of the bars illustrates the number of observations or the frequency of each item. These methods represent a progression. Each step, from tally to frequency to histogram, should make it easier for students to read and interpret their data.

Procedure

Day 1. ASSIGNMENT GIVEN

1. Introduce the activity by asking students to estimate the amount of water they use in a single day. (Be sure to specify whether your calculations will be in English or metric units.) You might wish to display one gallon or one liter containers to refresh students' memory of liquid measurement.
2. Give each student a copy of the PERSONAL WATER USE LIST on which they are to record their predictions and every drop of water they use in the next 24-hours, starting now. Explain that during this activity students will add information about their own water uses with that of other students and you, the teacher. When possible, students should measure the water they use. Otherwise, students should note the length of time water ran and observations associated with

the activity. Noting that water was running while teeth were brushed and how long it took to brush helps to more accurately estimate how much water was used. Encourage students to consider water used outside the home, such as at a car wash or the school cafeteria. Also encourage students to check with adult household members to learn if water-saving devices may have been added to sinks, showers, or toilets in the home. If so, these should be noted in the observations column. Adults can also help students check the dates inside toilet tank lids. Toilets made before the passage of the 1980 low-flow plumbing laws likely use five gallons per flush.

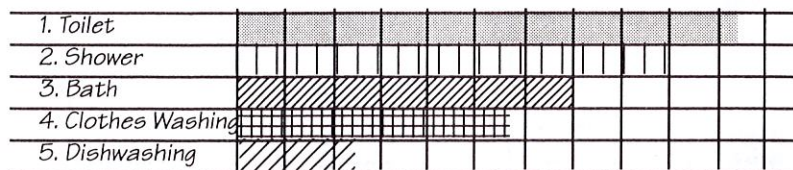
Day 2. STUDENTS DISPLAY AND ANALYZE DATA.

1. Set up the overhead with the master TALLY AND FREQUENCY CHART. Each team also should have a TALLY AND FREQUENCY CHART on which to make a single line tally (/) to represent each time each water use occurred by the team members. Encourage

students to add additional uses, as necessary, to the bottom of the list. While working in their teams, students should select one person who will transfer their team data to the tally column on the TALLY AND FREQUENCY CHART transparency displayed on the overhead. (Students could also verbally report data that the teacher records on the overhead.)

2. When all team data has been recorded in the tally column, lead students in counting the tally marks for a few items and in writing the number of tally marks in the Frequency column on the TALLY AND FREQUENCY CHART.
3. Let the teams determine the frequencies of the rest of the class data and identify the five most frequent uses of water by the class. Teams will then display this information on a histogram. They should write the top five uses in the blank spaces on the HISTOGRAMS: TOP WATER USES and shade in the bars with different colored pencils to show the number of observations or frequency of each use of water. See example.

HISTOGRAM: TOP FIVE WATER USERS



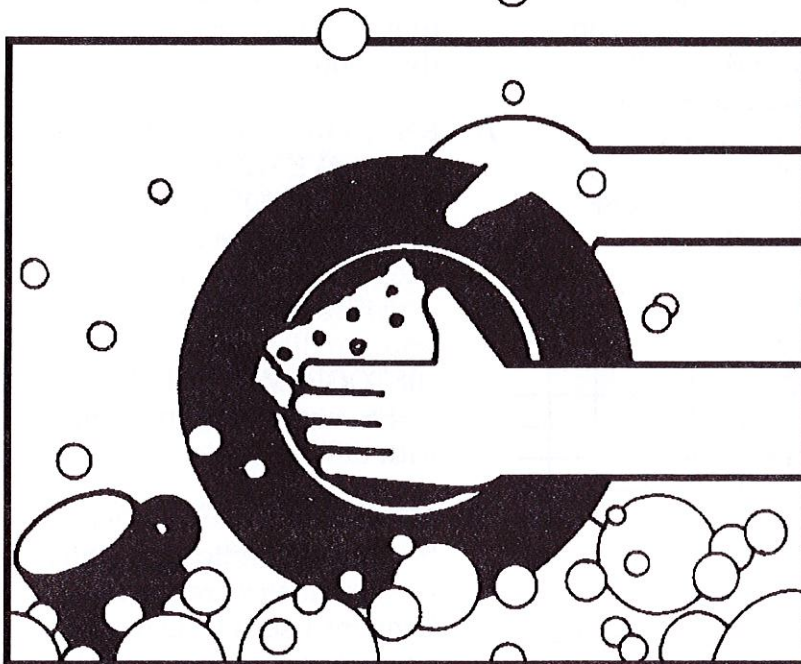
4. Have students look at the information in the tallies, the frequencies, and the

histograms. Ask: "Which method of reporting the findings of your survey do you prefer? Which is easiest to interpret?"

5. Then have the students transfer the frequency data from the TALLY AND FREQUENCY CHART to the AVERAGE WATER VOLUMES FOR TYPICAL ACTIVITIES sheet. Work with them to calculate the volume of water each class activity used during a 24-hour period.
6. Students will use these volumes to compute the class per capita daily water use. Tell students the residential per capita daily water use as calculated by municipal water suppliers in 1992 ranged from 93 to 533 gallons (352 to 2017 liters). Students' average per capita water use is probably lower for many reasons: students may not have considered landscape watering or water used in cooling, cooking or cleaning that may have occurred in their houses.
7. Return to the individual rows on the AVERAGE WATER VOLUMES FOR TYPICAL ACTIVITIES sheet. Students should select the five activities that used the most water to display on the HISTOGRAMS: TOP WATER USES, shading each volume with different colors.
8. Ask teams to display their histograms, indicating which five activities were the most frequent uses of water and which five activities used the

most water. Discuss the differences in the histograms depending on whether the occurrence of water-using activities or volume of water used was displayed.

9. Ask students to examine their histogram data and their PERSONAL WATER USE LIST. Remind them that we are all water users and that we can all help protect this precious resource. Ask: *"Which activities could you have done without? Which activities could you not have done without? Which activities do you consider the most important uses of water? Was any water wasted? Which activities should you reduce to conserve the most water? Which activities are you willing to reduce to conserve water?"*
10. Tell students that saving water can be surprisingly easy. Ask for one team to volunteer to call their city's



water conservation office for free brochures and information packets for each student in the class.

Extensions

1. Ask students to bring in water bills to learn actual residential water usage. Students should divide the number of gallons of water used by the number of days in each month and the number of household members, and graph the monthly per capita totals for the previous year. Most water bills report gallons used per month. If your bills report only hundreds of cubic feet (ccfs) used, remind students that one cubic foot (1 cf.) of water equals approximately 7.48 gallons, one hundred cubic feet (1 ccf) equals 748 gallons. Calculate the number of liters, too.
2. Have students predict what might be the five most frequent uses of water if they were students in 1800, 1900, in 2100, or if they lived in other countries. Have students discuss the largest volume of water uses in those other times or places.
3. Use the frequency data and volume of water used to make other kinds of graphs. Try line graphs, pictographs. Determine the proportions (or percentages) of the most popular choices for each group surveyed. Construct circle graphs (pie charts).

Evaluation

1. Pretest and post test:
Estimate how much water you use in one 24-hour period. Be sure to identify the unit of measurement.
2. Using the data that follow, identify the **frequency** for each student, and construct a **histogram** or bar graph to show the differences among students. What do you conclude based on this data?

Resources

American Water Works Association (AWWA). 1992. **It Takes a Lot of Water**. Denver, CO: American Water Works Association.

Arizona Department of Water Resources. **Using Water Wisely**.

Arizona Municipal Water Users Association. 1992. **How to Become Water Wise**.

Arizona Municipal Water Users Association. **Water Wise Tips**.

Massachusetts Water Resources Authority. "How Much Water Do You Really Use?" from **Water Wisdom**.

Metropolitan Water Districts of Southern California. 1993. **California Smith, Water Investigator**. Los Angeles: MWD.

Municipal Water District of Orange County. **Water: Student Resource Handout**.

Rossi, T.S. Personal conversations, 1993-94.

Tucson Water Conservation Office. **Beat the Peak: Reduce Your Peak Summer Water Use**.

University of Arizona. 1994. **Arizona WET: Water Education for Teachers**. Tucson: College of Agriculture, Water Resources Research Center.

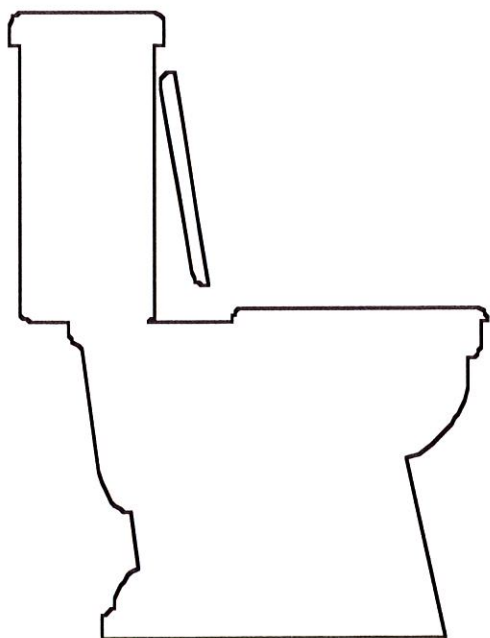
Water and Man. 1981. "What Are The Essential Rules?"

Western Regional Environmental Education Council. **Project WILD**.

Western Regional Environmental Education Council. **Project WILD Aquatic**.

STUDENTS	OUNCES OF WATER DRUNK IN ONE DAY	FREQUENCY
Bea		11
Dee		4
Jay		5
Kay		5

3. List five behaviors a student your age could change to save water.



THE WATER YOU USE - STUDENT PAGE

AVERAGE WATER VOLUMES FOR TYPICAL ACTIVITIES

Directions

1. Record the frequencies from the TALLY AND FREQUENCY CHART in the second column.
2. Then multiply the number of times each use occurred in one day by the volume of water each activity typically uses.
3. Total the total water used by your class for these activities. **VOLUME X FREQUENCY = TOTAL WATER USE**
4. Calculate the average amount of water used by each person in your class during one twenty-four hour period. This is the class per capita daily water use.

WATER USES	WATER VOLUME ACTIVITY USES (GALLONS/LITERS)	FREQUENCY (NUMBER OF USES IN DAY)	TOTAL WATER USE (GAL./L)
Bathing	tub 1/2 full	18 g./68 l	
	tub full	36 g./136 l	
Showering	5 minutes: regular	25 g./95 l	
	low-flow shower heads,	12.5 g./47.5 l	
	10 minutes: regular	50 g./190 l	
	low-flow	25 g./95 l	
	15 minutes: regular	75 g./285 l	
	low-flow	37.5 g./142.5 l	
	20 minutes: regular	100 g./380 l	
	low-flow	50 g./190 l	
Flushing toilet	low flush, 1.6 gpf	1.6 g./6 l	
	regular toilet/flush	5 g./19 l	
	with tank displacement	4 g./15 l	
Brushing teeth	wet brush, rinse	1/4 g./95 l	
	water running	2 g./7.5 l	
Washing face or hands	liquid soap, rinse	1/2 g./1.9 l	
	fill basin	1 g./3.785 l	
	water running	2 g./7.6 l	
Dishwashing	By hand: wash/rinse in filled basin	5 g./19 l	
	By hand: water running	30 g./114 l	
	Machine: short cycle	9 g./34 l	
	Machine: full cycle	16 g./61 l	
Clothes washing	Lowest water level	25 g./95 l	
	Highest water level	35 g./132 l	
Other			

TOTAL VOLUME USED _____ (gallons/liters)

CLASS PER CAPITA DAILY WATER USE = TOTAL VOLUME USED ÷ NUMBER OF STUDENTS & TEACHER

CLASS PER CAPITA DAILY WATER USE = _____ (gallons/liters) ÷ _____ = _____ (g./l)

THE WATER YOU USE - STUDENT PAGE

HISTOGRAMS: TOP WATER USES

Directions: Use the data from the TALLY AND FREQUENCY CHART to identify the most frequent uses of water of your class.

1. List the choices along the left column of the HISTOGRAM below.
2. Shade in the rows with different colors to show the frequency (or number of times) water was used.

HISTOGRAMS: MOST FREQUENT WATER USING ACTIVITIES

Top 5 Uses	Number of times water use occurred										
1.											
2.											
3.											
4.											
5.											
	0	10	20	30	40	50	60	70	80	90	100

Directions: Use AVERAGE WATER VOLUMES FOR TYPICAL ACTIVITIES to identify the five activities that required the greatest amount of water by your class.

1. List the choices along the left column of the HISTOGRAM below.
2. Shade in the rows with different colors to show the amount of water used.

HISTOGRAM: LARGEST VOLUME OF WATER USES

Top 5 Uses	Gallons										
1.											
2.											
3.											
4.											
5.											
	0	100	200	300	400	500	600	700	800	900	1000

Directions: Use AVERAGE WATER VOLUMES FOR TYPICAL ACTIVITIES to identify the five activities that required the greatest amount of water by your class.

1. List the choices along the left column of the HISTOGRAM below.
2. Shade in the rows with different colors to show the amount of water used.

METRIC HISTOGRAM: LARGEST VOLUME OF WATER USES

Top 5 Uses	Liters										
1.											
2.											
3.											
4.											
5.											
	0	300	600	900	1200	1500	1800	2100	2400	2700	3000