Let's Get Into An Argument Mini-Unit
Teacher Topic Guide – Bottled Water

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Bottled Water Overview

This unit addresses the scientific question of whether bottled water is as safe as or safer than tap water for drinking. There is no one correct answer to this question, although the question may be studied using scientific methods in specific cases. For example, most public water systems in the United States provide a safe water supply, but there are definitely problems with water safety in specific places (e.g., if you live or work in an old building with lead pipes; or if you live in a place where water supplies could be contaminated from things like agricultural, industrial, or mining activities in the area). Thus, in some locations, it may be the case that bottled water is safer than tap water. In other places, these two sources of water may be about the same in terms of safety for human consumption.

Similarly, not all brands of bottled water are the same. Some brands follow more stringent guidelines and some follow less stringent guidelines for safety. Different brands of water are extracted from different places (in some cases, water may actually be taken from the public water supply and bottled). Even the same brands of bottled water may be of different quality if the company extracts water from more than one location (e.g., for sales on the east and west coasts).

Students may learn from this activity that it is not possible to compare the safety of bottled versus tap water in general, but it is possible to do so for specific cases (e.g., comparing a specific brand of bottled water sold in one place with the public water available in that same place).

One socioscientific issue addressed by this unit is whether or not there should be stricter federal regulations and oversight for bottled water in the United States.

List of Articles

1. Naidenko, O., Leiba, N., Sharp, R., Houlihan, J. 2008. Bottled water contains disinfection byproducts, fertilizer residue, and pain medication. Excerpt adapted from http://www.ewg.org/reports/BottledWater/Bottled-Water-Quality-Investigation
2. Environmental Protection Agency. 2005. Bottled water basics. http://www.epa.gov/ogwdw/faq/pdfs/fs_healthseries_bottlewater.pdf
3. Business Wire. 2008. Yale scientist refutes study on bottled water by environmental working group. http://www.businesswire.com/portal/site/home/permalink/?ndmViewId=news_view&newsId=20081016005799&newsLang=en
4. International Bottled Water Association. 2008. Environmental working group report on bottled water contains sensationalized science and exaggerated claims. Excerpt adapted from http://www.bottledwater.org/content/environmental-working-group-report-bottled-water-contains-sensationalized-science-and-exagge

The EPA brochure tested at a grade 6 to 7 level on the Flesch-Kincaid Grade Level Reading Scale. The other articles tested at a 12th grade level. Please review the articles and decide if they are appropriate to use with your students, and/or if there may be ways to support and scaffold their use of these readings. Practice with texts from public sources intended for a general citizen audience can help prepare students to use information they will encounter in the media in their day-to-day lives after they graduate from high school.

Teacher Notes for Teaching this Topic

When teaching this topic, use the main unit teacher guide with the following alterations:

1. Use the procedural guidelines below to introduce the bottled water topic to students at the beginning of activity two.
2. Consider teaching the personal water choices application activity (see page 3) for bottled water.

Reading Considerations

Several of the articles have been edited for length. Links to the full text online are provided on the versions given to students. Even though the articles have been edited, these readings may still be challenging for students.

You may want to address this reading challenge with choices about how you adapt the lessons. For example, you might choose to jigsaw the articles, so that each student only reads one or two articles. Students who read the same articles can work in groups to discuss an argument's

strengths and weaknesses, then shift to a second group organization, in which each student has read a different article that they can discuss (or share out loud about).

Another possibility is to use this activity to emphasize the importance of reading in science and citizenship. Use reading comprehension supports to help students understand what they are reading about. Middle school teachers may want to team with English language teachers. Language teachers may be willing to use some language class time to develop a cross-curricular mini-unit that also encompasses reading for understanding in science and citizenship.

Introducing the Topic to Students

To introduce the topic and pique students' interest, begin with a class discussion to help students relate this topic to their own lives. You can use some of the following questions, or develop your own, to get students thinking about bottled water…

1. How many people in this class drink bottled water at least sometimes?
2. (Directed at students who raise hands) Why do you drink bottled water? Do you also drink tap water (i.e., water that comes out of the faucet)? Why or why not?
3. How can we tell whether or not the bottled water and tap water we drink are safe?
4. What kinds of information do people generally want to know about the water they are drinking?
5. If we do find information about the water we're drinking, how can we decide whether or not the information is trustworthy?

Personal Water Choices Follow-Up Activity

The articles that the students read may lead to increased interest in the water that students drink themselves. A great follow-up to this lesson is an investigation of the water quality that students drink. Go to your community water supplier's annual water quality report to find out about the water quality of tap water in your area. If students' homes and/or the school are on wells, find water quality reports that may be available from testing of the wells. Also, ask students what brands of bottled water that they drink. Contact the companies using contact info on the bottles and ask for their water quality reports.

Create tables and charts to compare water quality for tap water, well water, and bottled water in your area as appropriate. Ask students to summarize the findings. According to the water quality reports, does water quality for these different sources appear to differ? If yes, how do they differ?

Find out how much a gallon of tap water, well water, and different types of bottled water cost in your community. Using an estimate that a person drinks about a half gallon of water per day, figure out how much it costs a person who drinks tap water, versus well water, versus bottled water for a year's worth of drinking water.

Ask students, after having examined water quality of different sources, what choices they would now make about where to get their drinking water. What factors did they consider in their choices?

Example Response Key for "What's The Argument Here?" Handout (organized by article)

Titles of Articles You Read (use as many lines as you need): 1. Bottled water contains disinfection byproducts, fertilizer residue, and pain medication 2. Recent developments in bottled water quality and safety 3. Bottled water basics 4. Yale scientist refutes study on bottled water by environmental working group 5. Environmental working group report on bottled water contains sensationalized science and exaggerated claims
What socioscientific issue do the articles address? Several relevant socioscientific issues relate to this question --- including personal issues related to drinking water choices people make and societal questions related to whether bottled water production should be regulated to a larger degree by the US government (e.g., by changing the allowable levels of contaminants in bottled water and/or by enforcing regulations more aggressively).
What scientific question do the articles address? Is bottled water more or less safe to drink than tap water?

Article	Claim	Evidence	Reasoning
Bottled water contains disinfection byproducts, fertilizer residue, and pain medication	The EWG article claims that many popular brands of bottled water contain contaminants, often at levels that exceed standards set by states (e.g., California) and/or set by the bottled water industry itself, "Laboratory tests conducted for EWG at one of the country's leading water quality laboratories (University of Iowa Hygienic Laboratory) found that 10 popular brands of bottled water, purchased from grocery stores and other retailers in 9 states and the District of Columbia, contained 38 chemical pollutants altogether, with an average of 8 contaminants in each brand. More than one-third of the chemicals found are not regulated in bottled water. In the Sam's Choice and Acadia brands levels of some chemicals exceeded legal limits in California as well as industry-sponsored voluntary safety standards. Four brands were also contaminated with bacteria."	The EWG study had tests conducted by the University of Iowa's Hygienic Laboratory. The article outlines the data that were collected. Specific data are not included in the article, but they can be found if students go to the website provided at the top of the article.	EWG bases their claim on the data they collected and had tested by a third party laboratory. They extrapolate (generalize) that the level of contamination they found in their samples suggests that there is a similar (or at least some level) of contamination in many popular brands of bottled water.
Bottled water basics	Taste and quality of bottled water and tap water depend on the source and quality of the water, including its natural mineral content and how, or if, the water is treated. Both tap and bottled water can be expected to contain at least small amounts of contaminants. Contaminants do not necessarily pose a health risk. At high levels, some	The EPA brochure does not provide any specific evidence from studies that have been conducted. Instead, this brochure provides information for the public about things like drinking water regulations, different types of treatment methods, differences between tap water and bottled water, sources of drinking	Citizens need to educate themselves to make informed choices about which water to buy and/or drink. Because both tap water and bottled water characteristics can vary from place to place and company to company, individuals need to

	contaminants could pose a health risk.	water, etc.	understand specific ideas about drinking water to make informed decisions about what type of water makes sense for them to use.
Yale scientist refutes study on bottled water by environmental working group	"The Environmental Working Group's study on bottled water is troubling for both its lack of acknowledgement of scientifically based history and for failing to conduct controlled scientific experiments. Its conclusions unduly confuse consumers through faulty methodologies and unsubstantiated findings."	This article does not provide new evidence, and instead refutes evidence and arguments presented in the EWG (Environmental Working Group). The article does refer to guidelines provided by other sources, but no data are included. One example is a reference to an EPA finding about HPC as a measure of bacterial contamination.	Dr. Edberg critiques the EWG article and considers that its authors used poor scientific methods. For example, Edberg criticizes the EWG study for comparing cancer cell growth in tap water and bottled water --- indicating that there is chlorine in tap water, which would inhibit cell growth in culture.
Environmental working group report on bottled water contains sensationalized science and exaggerated claims	The IWBA press release claims that the EWG report on bottled water contains, "false claims and exaggerations about bottled water products" and that the EWG report is bad science because it, "is based on the faulty premise that if any substance is present in a bottled water product, even if it does not exceed the established regulatory limit or no standard has been set, then it's a health concern."	The IWBA press release is not based on an independent study, but it does draw on other scientific claims about substances in water. For example, it refers to the American Dental Association's statement that drinking fluoridated water is good for oral health. The press release also provides claims contradicting other things in the EWG report, for instance indicating the HPC bacteria has no adverse health consequences and that the FDA has set a minimum level for total dissolved solids in bottled water. The press release also indicates that it is problematic that the EWG report uses Walmart and Giant brands of bottled water	The IBWA is suggesting that the EWG report is faulty because of different problems including that EWG referred to regulations from California that are more strict that FDA regulations for bottled water, that EWG indicated that many substances are pollutants which in fact (according to IBWA) do not have adverse health affects and may even be beneficial (such as fluoride), and that EWG misrepresented the information that bottled water companies provide to

		because these brands are not members of the IWBA. One other piece of evidence provided is that bottled water is not just tap water, and that when tap water is used for bottled water, the bottled water companies use additional treatments before bottling the water.	consumers about their products.

Example Response Key for "Evaluating Arguments in the Articles" Handout

Scientific Argument One

Restate the claim for this argument: Many brands of bottled water contain contaminants and chemicals that are harmful to human health. (From EWG article)		
Criterion (Factor)	**Strength (S), Neutral (N), or Weakness (W)**	**Explain why the scientific argument is strong or weak for each criterion you list.**
Is there scientific evidence to support the claim	Strength	EWG conducted a study and collected and analyzed data from samples of bottled water. They also conducted a survey of 228 brands to see what information was provided about bottled water brands on websites, labels and other marketing materials.
Is the sample size sufficient	Could be strength, neutral or weakness	The study tested 10 brands. There are at least 228 brands available in the United States (probably more). EWG tested about 4% of brands. The bottled water industry might consider this to be a small sample. The EWG may have felt it was sufficient, and/or that they tested brands that are particularly popular around the country. The reasonableness of a rating will depend on how the student justifies their rating.
Were appropriate measures used	Could be strength, neutral or weakness	The reasonableness of a rating will again depend on how the student justifies their rating. The student may use the other articles to find problems with the measures (e.g., problem with using tap water for growing cells cited by Dr. Edberg, problem with how EWG is identifying harmful contaminants --- is fluoride harmful or beneficial??), or they may indicate

		appropriateness of sending samples to a third party, reputable lab to conduct the analyses.
Have the results been peer reviewed	Weakness	There is no indication that the EWG report was peer reviewed. It has not been published in a scientific journal.

Scientific Argument Two

Restate the claim for this argument: The Environmental Working Group report on bottled water relies on bad science and exaggerated claims (from IBWA press release)		
Criterion (Factor)	**Strength (S), Neutral (N), or Weakness (W)**	**Explain why the scientific argument is strong or weak for each criterion you list.**
Is there scientific evidence to support the claim	Weakness	This press release didn't provide any actual scientific data to back up its claims. Instead it used mainly scientific reasoning and alternative claims to refute the EWG argument.

Did someone who might have a bias fund or carry out this work	Weakness	This press release comes from the International Bottled Water Association, which has an interest in maintaining a positive reputation for bottled water.
Have multiple scientists found similar results	Neutral	The press release does call on some other agencies that would depend on scientists for making conclusions (e.g., American Dental Association suggests use of fluoride to prevent cavities, which is based on a record of scientific studies over time).