Students use a free, authoritative online resource for environmental health issues that supports argument-based inquiry.

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The effects of environmental pollutants on human and environmental health are a growing concern. Several years after Hurricane Katrina, water quality continued to be monitored in New Orleans (Roper, Weiss, and Wheeler 2008). First responders to the September 11, 2001, attack in New York City continue to suffer health problems caused by exposure to toxic pollutants (Gardner 2011). In 2003, mercury was found in Ballou High School in Washington, D.C., in the school science lab, on student’s clothing, and in some of the students’ homes (EPA 2012). More recently, the Environmental Working Group found chromium-6, the toxic chemical made famous by environmental activist Erin Brockovich, in the tap water of 31 U.S. cities (Sutton 2010).

These examples raise important questions, such as “How do we know what we can safely drink?” “What is our exposure to toxins?” and “How can we respond to growing environmental health challenges?”

Little science curriculum focuses specifically on environmental health, and little data exists on the extent to which environmental health is taught on a national level (Brown 2004). Students have the right to access information that can enable them to make informed choices.

Scientific argumentation
In the political arena, legislators, lobbyists, environmental groups, and other stakeholders argue from vastly different perspectives issues of environmental health, such as the causes and consequences of global warming. Scientists, for their part, use argumentation to make progress in developing and supporting coherent theories (NRC 2007).

For several decades, education researchers have argued for the need to integrate scientific argumentation into the high school science classroom (Driver, Newton, and Osborne 2000; Kuhn 1993; Sampson and Grooms 2010). Scientific argumentation involves making claims, supporting them with evidence, providing “warrants” or reasoning for how the evidence supports the claims, anticipating counterclaims, and preparing to respond to those counterclaims (Toulmin 1958).

Students often have difficulty differentiating between their causal beliefs or explanations and the evidence that could support those beliefs and explanations (Kuhn 1989) and thus may struggle with scientific argumentation. Other evidence suggests that, given appropriate opportunities and support, students can argue productively (Berland and McNeill 2010). In the secondary classroom, scientific argumentation can occur both informally, as students discuss possible explanations for scientific phenomena, and formally, through structured debates or mock legislative hearings about socio-scientific issues. Such argumentation has a role in scientific progress and is fundamental to understanding the nature of science (NRC 2007).

About Tox Town
This article will describe a sequence of lessons surrounding a mock legislative hearing to help students learn about environmental health and participate in argumentation. The lessons, appropriate for biology, chemistry, or environmental science classes, use Tox Town (see “On the web”), a free online resource developed by the National Library of Medicine, as the main source of information. Tox Town offers:

- knowledge of everyday locations, such as cities, farms, or schools, where toxic chemicals may exist
- authoritative, nontechnical information about chemicals
- descriptions of how the environment can impact human health
- online resources on environmental health topics

Tox Town, which uses graphics, sounds, and animation, is a companion to the extensive TOXNET collection of databases typically used by toxicologists and health professionals. Figure 1 shows the Tox Town home page.
The school water use and safety legislative hearing

For this mock legislative hearing, some students serve as members of a committee taking testimony to prepare a report to a state legislature about possible state involvement in the control of school water resources; other students serve as representatives of witness groups who try to influence the committee’s decisions in ways that favor their interests. Students must consider the following driving question: “Should the committee suggest the legislature pass a law to require schools to sell bottled water?” This activity is modeled after DeGasperis’s (1998) “Animal Welfare Hearing.” Other activity extensions are available online (see “On the web”).

This activity addresses several of the National Science Education Standards (NRC 1996) (Figure 2) and is consistent with A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (NRC 2011).

The activity begins with introducing the students to the idea of participating in the hearings, modeled to simulate a state legislative hearing, and describing the general roles of the committee and interest groups. The goal of this particular hearing is to help the committee make informed recommendations about whether schools should be required to sell bottled water. Interest groups (Figure 3) will testify to try to steer committee decisions toward their interests. Some students assume the roles of representatives of particular interest groups and others of committee members who make decisions and recommendations (guidelines for committee members and interest groups are available online [see “On the web”]). Students should develop an understanding of their stakeholders’ potential points of view.

More on the the School Water Use and Safety Legislative Hearing activity.

We adapted the hearing structure of the Tox Town activity from “The Animal Welfare Hearings,” developed by one of our colleagues (DeGasperis 1998). Chemistry in the Community (ACS 2006) provides a similar activity, in which students participate in a simulated town council meeting to discuss the causes of a local fish kill.

The legislative hearing activity is unique because students use Tox Town as a central resource for gathering information and can easily connect to the user-friendly interface from any classroom or lab with internet access. Students can also relate to the issue of the safety, drinkability, and environmental impact of water. This lesson also emphasizes the importance of argumentation in scientific discourse and the role the teacher plays in supporting student argumentation.

Have students learn to navigate the Tox Town website by doing the quick exercises available to them through the “For Teachers” link. Then assign roles for the hearing. In a class of 28, four students can participate in each of the six interest groups, and four students can find places on the hearing committee. Smaller classes can eliminate two of the interest groups (ideally two with differing perspectives).

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FIGURE 2

Addressing the National Science Education Standards (NRC 1996)

<table>
<thead>
<tr>
<th>National Science Education Standards</th>
<th>Related bottled water debate activities</th>
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</thead>
<tbody>
<tr>
<td><strong>Science as inquiry standard</strong></td>
<td>🔄 Students use Tox Town to gather data and information relevant to the different interest groups’ arguments.</td>
</tr>
<tr>
<td>🔄 Students develop skills necessary to be independent inquirers about the natural world.</td>
<td>🔄 Students construct and analyze arguments for and against the various proposals.</td>
</tr>
<tr>
<td><strong>Science in personal and social perspectives standard</strong></td>
<td>🔄 Preparing for the hearing introduces students to the effects of biological and chemical agents on water quality.</td>
</tr>
<tr>
<td>🔄 Students develop understandings of environmental quality.</td>
<td>🔄 Preparing for the hearing introduces students to issues of chemicals found in plastic water bottles.</td>
</tr>
<tr>
<td>🔄 Students develop understandings of the role of science and technology in local, national, and global challenges.</td>
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</tbody>
</table>
The interest groups usually need two 45-minute class periods to use Tox Town to develop their testimony and consider how they would respond to other groups’ arguments. During this time, the members of the committee decide how to run the hearing, what questions to ask of each group, and how to structure their discussions to make recommendations to the state legislature. Teachers can provide committee members with a graphic organizer as a template for planning the hearing.

Students can use the graphic or text interfaces on the Tox Town website to access abundant information on issues related to drinking water, such as water quality, plastics, and recycling. A typical search for information on drinking water can begin by using the location and chemical buttons at the top of the home page. Students can navigate to the list of locations and click on “drinking water.” This page lists MedlinePlus resources compiled by the National Library of Medicine and National Institutes of Health and links from other authoritative agencies and organizations, such as the Environmental Protection Agency, Centers for Disease Control, and the Food and Drug Administration. These links lead to information on bottled water, filtration facts, tap water, chemical and biological drinking water contaminants, and the FDA regulation of bottled water. Students can continue their searching by clicking on additional links found on any of these primary pages.

During this preparatory time, the teacher should circulate among the groups and the committee, reminding the interest groups to be prepared to back up their statements with evidence and to anticipate how other groups will rebut their arguments.

The hearing
The hearing takes approximately two 45-minute class periods. Teachers should encourage the committee to structure time for introductory statements, followed by a period in which the committee and the other groups can question witnesses, followed by a summary statement from each group. This structure lends itself to the display of arguments, counterarguments, and rebuttals.

**School Water Use and Safety Committee Interest Group Descriptions**

- **State Bottled-Water Association**
  You represent vendors of bottled water who say that bottled water is a clean, safe alternative to tap water and water from school water fountains. You support the sale of bottled water in schools in order to increase vendor profits.

- **People Opposed to Packaging! (POP!)**
  You are radically opposed to widespread commercialization and packaging. There is so much stuff in packages that can end up in things we eat and drink, and we just don’t know enough about the long-term effects to let this commercialization and packaging mania continue. You won’t be silenced by corporations and politicians!

- **Association of Private State Water Treatment Plants**
  You work to ensure the safety of tap water through extensive water testing and other means. You believe there are all sorts of problems associated with requiring the sale of bottled water. Your interests motivate you to save costs, continue to assure the public that tap water is safe, and maintain and increase your current client base.

- **Environmental Action Committee**
  You are a moderate, non-profit group primarily concerned with environmental issues. You worry about pollution in all its forms, including toxic chemicals in containers and packaging. You seek ways to ensure the health of the public and the environment.

- **Council of State Parent, Teacher, and Student Associations**
  You are primarily concerned with issues of student health and safety, maximizing instructional time, and keeping schools clean and environmentally safe. Your interests motivate you to find solutions that will balance these concerns.

- **American Medical Association**
  You represent the interests of physicians. You argue that people, especially children, drink too little water and too much juice and soda. You support efforts to encourage and enable children to drink plentiful clean, healthy water throughout the school day.
Assessment

Much of the assessment in this activity is ongoing formative assessment (Black and Wiliam 1998), as the teacher circulates among the groups before the hearing and follows the arguments as the hearing proceeds. Several questions can guide the assessment: Do the students draw on evidence they have researched through the Tox Town website to support their groups’ positions? Do they anticipate other groups’ arguments and gather evidence to rebut those arguments? Do they anticipate how they may rebut challenges to their own arguments?

After the hearing, committee members meet to decide on the relevant issues. Meanwhile, students in the interest groups can be given a set of questions to assess their understanding of the issues raised in the hearing and their developing practices of argumentation: What do they personally think about the issues raised in the hearing? What arguments would they make and what evidence would they use to support their arguments? What would someone say who disagreed with them? How would they respond?

Implications and future directions

The activity described here is just one possible use of Tox Town. We continue to develop curriculum, in collaboration with teachers, for using Tox Town to integrate issues of argumentation and environmental health. We encourage other teachers and curriculum development groups to use this free, authoritative resource to supplement their curricula. Teachers can use this site to hone in on a particular topic of their choice. Other potential topics include: global warming, air quality and human health, and chemicals in food and food safety.

There is increased interest in science education in both socio-scientific issues and argumentation. Using Tox Town as a resource as described here can provide students with opportunities to study important issues in environmental health and gain valuable practice in scientific argumentation.

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On the web

Tox Town: www.toxtown.nlm.nih.gov


References