Educating Young People about Environmental Health for Informed Social Action

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ABSTRACT

Whereas environmental health education is rapidly becoming a global priority, it still receives little attention in schools. This paper describes a U.S. National Library of Medicine program, aiming to support environmental health education in grades 6-12 in U.S. schools. The program has four components: (1) developing reliable online resources that provide quality environmental health information; (2) creating lesson plans that integrate our resources into the classroom and extracurricular activities; (3) engaging teachers by inviting collaborations and promoting our resources and activities; and (4) conducting educational research that provides a foundation for the other components. The paper describes specific educational resources and activities and grounds them in learning theories from the fields of cognitive psychology and science education.

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Importance and Challenges of Environmental Health Education

We are living at a time when human impact on the environment and the resulting impact of the environment on human health are rapidly growing global concerns. The top international priorities include slowing the rate of human-induced climate change, protecting water and air quality, reducing the health impact of disasters, and minimizing human exposure to toxic chemicals. There is also growing concern that current efforts aiming to curb climate change are insufficient. In these circumstances, it is essential that science education produces citizens capable of intelligent engagement with environmental health concerns. As educators in a democratic society, we believe that the public's understanding of science can result in social action and more effective policy. However, is the public well equipped for participating in the environmental health discourse? A Pew Global Attitudes Survey (2009) found that "majorities [of the population, based on survey samples] in 23 of 25 countries agree that protecting the environment should be given priority, even at the cost of slower economic growth and job losses." These beliefs, however, are not always consistent. In 11 of the 25 nations that participated in the survey, majorities disagree that "people should pay higher prices to deal with climate change." When it comes to global warming, majorities in only 15 of the 25 countries see this issue as "very serious." Countries where the latter ("very serious") view is not held by the majority include such major global players as the U.S., Russia, and China. This is particularly concerning considering the relatively large contribution these players make to global carbon emissions.

The classroom seems like a natural place to teach about the environment and human health. Unfortunately, environmental health receives little attention in schools. In the U.S., it is virtually absent from the health and science curriculum. To explore this issue, we conducted discussion groups with elementary (up to grade 5) and middle (grades 6-8) school science and health teachers in four US states. Whereas many teachers viewed environmental health as an important topic, they pointed to several barriers that prevented them from teaching it. These barriers included limited classroom time, pressure to teach to district-imposed guidelines, and the teachers' perception that they lacked appropriate background knowledge in environmental health. Barriers, of course, are likely to differ by country. Nevertheless, it is our impression, from informal conversations with science educators outside the U.S., that environmental health is globally perceived as important, but introducing it into the classroom usually requires a non-trivial effort.

Ways to Bring Environmental Health Education into the Schools

Authors of this paper represent two interest groups outside the schools: federal developers of information resources (*AK*, *KM* and *JFK*) in the Division of Specialized Information Services of the U.S. National Library of Medicine, National Institutes of Health and science education

researchers (*AK* and *DML*). The Division of Specialized Information Services develops thematic health information resources for health professionals and consumers, focusing on toxicology and environmental health. We also develop resources for special population groups, including school teachers and students, and conduct a variety of educational programs and activities. It often happens that outsiders like ourselves advocate educational change in school systems. Our approach has four related components, intended to strengthen one another and the overall success of our mission. They are: (1) developing reliable online resources that provide quality environmental health information; (2) creating lesson plans that integrate our resources into the classroom and extracurricular activities; (3) engaging teachers by inviting collaborations and promoting our resources and activities; and (4) conducting educational research that provides a foundation for the other components.

Our discussion groups with teachers suggest that in order to fit in the classroom, resources need to connect to the existing curriculum. To meet this goal, we scan textbooks and curricular guidelines and invite teachers to evaluate our Websites. We also engage teachers as collaborators in making architectural decisions about our Websites. Finally, we meet with school administrators and promote our resources at conferences and events attended by teachers, where we demonstrate how our environmental health materials can be used in the biology, chemistry and environmental science classroom.

Even when we design resources that are endorsed by teachers and connect to existing classroom topics, the challenge of limited classroom time remains. To address this, we advocate for creative implementation of environmental health topics into extracurricular activities. One potential place is afterschool clubs. Many U.S. school districts sponsor such clubs, and many schools have a science club or an environmental club (these rarely include a focus on human health). These clubs are led by our natural collaborators - teachers who are enthusiastic about the environment and concerned about the human impact on it. Clubs also give teachers much more freedom to select topics, materials and activities than does the regular classroom. Part of this paper describes our effort in collaborating with teachers on developing environmental health afterschool club curricula.

K-12 Environmental Health Resources from the U.S. National Library of Medicine

In this section, we describe some of our online environmental health resources for students and above. We start with resources for younger students (grades K-5) followed by middle school and high school resources (grades 6-12). Lastly, we describe our general environmental health and toxicology resources that can be adapted for advanced classroom studies in chemistry and environmental health.

ToxMystery (Figure 1) is an interactive Web game designed to help teach children ages 6 -10 about hazardous substances commonly found in the home. Children search rooms throughout the house to locate the hazardous substances. Once a substance is identified, children learn about the health effects caused by its use or misuse.

The **Environmental Health Student Portal** (Figure 2) is our newest resource for students and teachers. Unlike our resources for the general health consumers, the portal was developed specifically for school use, following in-depth needs assessment among teachers. The sections of the portal are designed to reflect existing topics in the U.S. middle schools (grades 6-8).

The sections in the portal include *Air Pollution*, *Chemicals*, *Climate Change*, and *Water Pollution*. The *Chemicals* section describes hazardous substances in the everyday environment, focusing on the chemicals and compounds that are often covered in the middle school science curriculum (e.g., mercury, lead, arsenic, plastics, pesticides). *Climate Change* addresses causes of greenhouse gases and describes the effect of climate change on the weather and on human health. The *Water Pollution* section provides basic information about the water cycle, specific chemical and pollutants that enter the cycle, water treatment, disasters caused by water (floods, hurricanes), and water-borne diseases. The *Air Pollution* section is currently under construction. To support a variety of classroom needs, the site links to articles, games, activities, and videos.

Tox Town (Figure 3) is a Website that provides information about environmental health concerns in everyday environments to students in grade 9 and above. This Website is designed to inform about the following:

- Everyday locations where one might find toxic chemicals;
- Non-technical descriptions of chemicals;
- Links to selected, authoritative chemical information on the Internet;
- How the environment can impact human health; and
- Internet resources on environmental health topics.

To highlight the connection between chemical, the environment, and health, Tox Town is organized into five interactive graphic neighborhoods, City, Farm, Town, U.S.-Mexican Border and Port. Each neighborhood has a number of locations where hazardous chemicals can be found.

Examples of locations include Factory, Food Services, Landfill, River and School. Tox Town also contains sections on over 40 chemicals (focusing on their environmental health impact), updated links on disaster topics (including those related to recent events, such as oil spills), and teachers' pages with activities and resources for the classroom. An analogous version of Tox Town exists in Spanish. Teachers can assign Tox Town to their students knowing that all links have been vetted for accuracy and reliability.

Tox Town has been used in both middle school (grades 6-8) and high school (grades 9-12) as a resource for homework and school projects. Students have used Tox Town to learn more about specific chemicals assigned by their teachers. Middle school science teachers have also used Tox Town in Spanish immersion classes since there is both an English version and a Spanish translation of most pages. An after-school club for middle school students uses Tox Town as a tool to teach students about potentially toxic chemicals in their environment. Tox Town is also a featured resource in the lesson plans sequences, described in the next section.

The **Household Products Database** (Figure 4) provides information about potential health effects, safety and handling of over 10,000 brands of household products. The database is primarily for researchers and consumers, interested in answering questions about chemicals contained in specific products and brands and acute and chronic health effects of those chemicals. In the classroom, this database may provide valuable basis for linking abstract chemistry concepts to the daily context of things that can be found under the kitchen sink or on the shelves in the bathroom.

Other Resources

Our other resources for professionals and the general public may be adapted for advanced classroom studies in chemistry and environmental health. These include, among others:

- **Chemical Carcinogenesis Research Information System, CCRIS** (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?CCRIS) contains chemical records with carcinogenicity, mutagenicity, tumor promotion, and tumor inhibition test results.
- **ChemIDplus Lite** (http://chem.sis.nlm.nih.gov/chemidplus/chemidlite.jsp) and **ChemIDplus Advanced** (http://chem.sis.nlm.nih.gov/chemidplus/) provides information about chemicals, including 3-D structural diagrams, and includes links to many environmental health and toxicology resources.
- **GENE-TOX** (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?GENETOX.htm) contains peer-reviewed genetic toxicology test data for over 3,000 chemicals.
- **Haz-Map (**http://hazmap.nlm.nih.gov/) is a database of information on the health effects of exposure to chemical and biological substances at work and home.
- **Hazardous Substance Database, HSDB** (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB) is a comprehensive, peer-reviewed toxicology database for about 5,000 chemicals.
- **International Toxicity Estimates for Risk, ITER** (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?iter) provides a comparison of international risk assessment information for chemicals in a side-by-side format and explains differences in risk values derived by different organizations.

For a complete list of professional and consumer health resources from the Division of Specialized Information Services, U.S. National Library of Medicine, visit our Website: http://sis.nlm.nih.gov/).

Evidence-based Approach to Teaching Environmental Health: Lessons from Psychology and Science Education Research

Our Websites are tools that can aid in the instructional process, but do not constitute instruction in and of themselves. Successful introduction of environmental health education depends on a number of components, including the quality of instructional activities that incorporate the tools. In this section, we describe characteristics of successful instructional approaches, identified in cognitive psychology and science education research. By "successful," we mean approaches that result in lasting learning, applicable to the world outside the classroom.

First of all, successful approaches provide deep understanding of the underlying concepts, rather than the ability to recite isolated facts. Research in many areas of science education demonstrates that certain depth of conceptual understanding is a prerequisite for effective problem solving and decision-making. Patel, Kaufman, and Arocha (1999) provide a review in the health domain. For example, in the domain of HIV, Keselman, Kaufman and Patel (2004) demonstrated that mere factual knowledge that HIV is sexually transmitted and incurable does not prevent adolescents from accepting myths that

contradict these facts, whereas understanding cellular-level mechanisms of HIV biology does. For environmental health education, this suggests that simply telling students that global climate change is caused by human carbon emission may not equip them with the robust conceptual understanding necessary to critically evaluate the social discourse around global warming. Understanding how greenhouse gases affect the earth's temperature and impact weather patterns, and how this in turn affects the environment, economy and human health is likely to produce a better foundation for informed decision-making.

Second of all, if the goal of science education is to equip the students with critical reasoning and information evaluation skills, it is worthwhile to focus on these skills directly, rather than assume that greater knowledge alone will lead to better reasoning. When it comes to skills instruction, science instruction has traditionally focused on the skills involved in carrying out laboratory activities (e.g., measurement). However, lay adults' engagement with environmental health issues is less likely to be "hands-on" than it is to involve reasoning and participation in social discourse. Social action requires skills that are referred to as "informal reasoning" (Perkins, 1985), which include locating and evaluating information produced by others and formulating, sharing and defending informed opinions. This type of reasoning is a form of internalized argument, which becomes externalized in social interactions. In the recent years, many science education researchers have come to view argumentation as a core scientific practice, which should be included as an important goal of science education (Kuhn, 2010; NRC, 2007). Intervention studies suggest that supporting the development of argumentation skills via sustained practice or direct instruction results in transfer to novel situations (Kuhn, 2010; Larson, Britt & Kurby, 2009; Schworm & Renkl, 2007). For example, Zohar and Nemet (2002) showed that explicit instruction in argumentation about socio-scientific implications of genetics improved students' understanding of the advanced genetics concepts and quality of argumentation. Theories of how people learn inform environmental health education programs, and our understanding of the centrality of argumentation in learning and applying knowledge of socio-scientific issues informs our work with teachers.

An Example of Our Collaborative Curriculum Development Projects with Teachers

In an attempt to support environmental health education in the schools, we attempt to develop and promote lesson plans that (1) incorporate educational research theories described in the previous section and (2) engage teachers as collaborators in these activities. Collaborating with teachers is relatively new to most of us. As part of this experience, we are learning to recognize and reconcile differences between the priorities of educational researchers and practicing teachers. Researchers' objectives are driven by learning theories. Teachers, on the other hand, value theories, but prioritize practical issues and constraints. Despite the challenge in finding the common language, joining forces is beneficial for both sides. To facilitate future collaborations, we are conducting research into the nature of communication in collaborative teacher-researcher curriculum development projects.

Below is the description of two pilot projects, in which activities are centered around the Tox Town Website.

Collaborative Development of Afterschool Environmental Health Club Curriculum for the Middle School (Grades 6-8)

The objective of this project was to develop a middle school afterschool club curriculum to promote socio-scientific argumentation about environmental health using Tox Town. The project team involved two developers and a science education researcher from the National Library, a science education researcher from American University and a team of teachers from a public middle school, including two science teachers, a social studies teacher, and a language arts teacher.

We (NLM and university participants) developed the initial project specifications. We expected the curriculum to include many argumentation activities that support the development of critical thinking skills, essential to the application of scientific knowledge in daily life. The initial specifications involved explicit emphasis on helping students to:

- Appreciate the importance of argumentation;
- Gain respect for evidence;
- Learn to collect, organize and evaluate secondary sources;
- Learn to make a convincing argument, anticipating and rebutting the opposition; and
- Apply argumentation in a socially relevant way.

The club was to include 4-6 thematic units, each covering a new environmental health issue. We wanted the students to develop in-depth understanding of the topics, but did not have strong preferences for any particular topics, and preferred to emphasize the development of argumentation skills.

The teachers were enthusiastic about introducing students to environmental health topics.

Like us, they perceived the science of environmental health as highly relevant to global societal concerns and daily life. The teachers also found a lot of value in collaborating with colleagues across the school disciplines and connecting scientific knowledge to social activism. However, we also found differences in teachers' and researchers' perspectives and priorities. Attempting to integrate both perspectives in the project became a major force in shaping the resulting curriculum.

Although the researchers placed the highest value on supporting students' argumentation skills, teachers' priorities were frequently guided by a shared sense of what was appropriate to do in a club. To the teachers, the greatest challenge was engaging the students' interest, covering a broad range of environmental health topics within a limited amount of time, and providing adequate level of support and structure to allow smooth progress. Teachers felt that to maintain students' engagement, the club required a laboratory component within each unit. This shifted the focus of the club from evaluating and integrating information to conducting hands-on activities. Whereas teachers valued argumentation, they viewed it as a pinnacle activity, which required significant content knowledge and information skills, rather than a vehicle for the development of scientific reasoning. As researchers, we suggested incorporating sustained argumentation into each thematic unit of the club. Teachers chose to focus the early units of prerequisite skills on information seeking and evaluation, concluding the club with the major debate unit.

The project is currently in progress. The first of the four units of the club curriculum has been fully developed, and is about to be implemented. This unit is significantly different from our initial design specifications. Students use Tox Town to research potentially hazardous chemicals that can be found in tap water, test the quality of water in the school water fountains, and prepare posters and presentations, informing the school community about the results of their testing. Although there is less emphasis on the evidence evaluation and anticipation of the opposition than originally intended, the unit provides a thoughtful, unique integration of background information seeking and hands-on laboratory activities. We hope that our subsequent analysis of team interactions provides us with insights for optimizing shared meaning construction across teacher-researcher communities, thus informing future collaborative efforts.

Mock Legislative Hearing for High School (Grades 9-12) Environmental Science Classroom

As our afterschool club curriculum evolved away from the argumentation skills focus, we decided to implement an argumentation-based Tox Town unit as a separate project. Two high school teachers from Washington, DC, expressed interest in this project, focusing on debating environmental health issues as part of their environmental science curriculum. Similarly to the first unit of the afterschool club, the theme is water quality. The objective is to conduct a mock legislative hearing, deciding how the quality of the schools' drinking water ought to be regulated. Some student participants assume membership in six special interest groups, including an association of bottled water vendors, a radical group opposed to widespread commercialization and packaging, the American Medical Association, and more. Other students develop the format of the hearing that gives each group an equal opportunity to voice their proposal and to respond to the others' concerns. Students are asked to provide information that would enable the committee to decide on the following issues:

- Should the committee suggest the legislature pass a law to require schools to sell bottled water?
- How often should the committee recommend that drinking water be tested? Who should test it?
- What kind of labeling should be required of bottled water sold in school?
- Should the legislature regulate or subsidize bottled water sold in schools?

The lessons' sequence (still in the development stage) addresses several of the U.S. National Science Education Standards (NRC, 1996), particularly *Science as Inquiry* and *Science in Personal and Social Perspectives*.

Summary

Whereas environmental health issues are at the forefront of global societal concerns, school environmental health education is lagging behind. Bringing environmental health education into schools requires a combination of top-level institutional change and grassroots creativity. This paper described a specific initiative, aiming to increase US students' knowledge of environmental health issues and informed citizenship skills. The effort is conducted through developing environmental health resources for teachers and students, building activities and lesson plans that integrate these resources, leading school outreach and collaborating with teachers, and conducting research into issues that surround socio-scientific thinking and curriculum development. We hope that such an approach contributes to educating a generation of citizens capable of engaging in informed social activism and working towards

effective solutions to pressing environmental health problems.

Figure 1. ToxMystery (http://toxmystery.nlm.nih.gov/)

Targeted age group: grades K-5

Figure 2. Environmental Health Student Portal (http://kidsenvirohealth.nlm.nih.gov/)

Targeted age group: grades 6-8

Figure 3. Tox Town (http://toxtown.nlm.nih.gov/)

Targeted age group: grades 9-12, college students, educators and general public interested in environmental health

Figure 4. Household Products Database (http://hpd.nlm.nih.gov/)

Targeted age group: grades 6-12, researchers, general public

References

Keselman A., Kaufman D.R., & Patel, V.L. (2004). "You can exercise your way out of HIV" and other stories: the role of biological knowledge in adolescents' evaluation of myths. *Science Education*, *88*(4), 548-573.

Kuhn, D. (2010). Teaching and learning science as argument. *Science Education. 94*(5), 810–824.

Larson, A.A., Britt, M.A., & Kurby, C. *(2009)*. Improving students' evaluation of informal arguments. *Journal of Experimental Education*, *77*, 339–366.

National Research Council. (1996). *The national science education standards.* Washington, DC: National Academy Press.

NRC. (2007). *Taking science to school: learning and teaching science in grades K-8*. Washington, DC: Committee on Science Learning, Kindergarten through Eighth Grade.

Patel, V.L., Kaufman, D.R., & Arocha, J.F. (1999). Conceptual change in the biomedical and health sciences domain. In Glaser, R. (ed.), *Advances in instructional psychology* (pp. 329–392). Mahwah, NJ: Lawrence Erlbaum Publishers.

Perkins, D.N. (1985). Postprimary education has little impact on informal reasoning. *Journal of Educational Psychology*, *77(5)*, 562-571.

Pew Global Attitudes Survey (2009). Retrieved May 26, 2011 from: http://pewresearch.org/pubs/1427/global-warming-major-problem-around-world-americans-less-concerned.

Schworm, S., & Renkl, A. *(2007)*. Learning argumentation skills through the use of prompts for self-explaining examples. *Journal of Educational Psychology*, *99*, 285–296.

Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching*, *39*, 35–62.

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