



A Science Club Takes ACTION

*Knowledge about water quality
and soil contamination inspires
students and their families.*

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The after-school science club at Galtier Math, Science, and Technology Elementary Magnet School in St. Paul, Minnesota, learned some valuable lessons when they took their newfound knowledge about pollution into their homes. After learning about the effects of various contaminants on health and what informed citizens can do about it, students tested their tap water and soil. As a result, both students and their parents changed behaviors. The experience proved valuable for the educators, too, by reminding us of the power of integrating science with real-world issues and how effective they can be in guiding children to make more informed decisions about their world. It is our hope that the activity described here encourages other elementary students and teachers to examine their surroundings while exploring scientific concepts and processes.

The Club

During the 2005–2006 school year, 20 fourth-through sixth-grade students participated in weekly meetings during the after-school science club session, from March through May. The club was conducted by three graduate fellows in environmental science fields at the University of Minnesota as part of a National Science Foundation GK–12 grant to promote science education in inner-city schools. The overall goal was to increase student awareness of the impact of human activities on the environment. Because students attending Galtier are disproportionately from socioeconomic groups that are likely to live in areas of environmental contamination (Powell and Stewart 2001), this topic had particular meaning for the student audience.

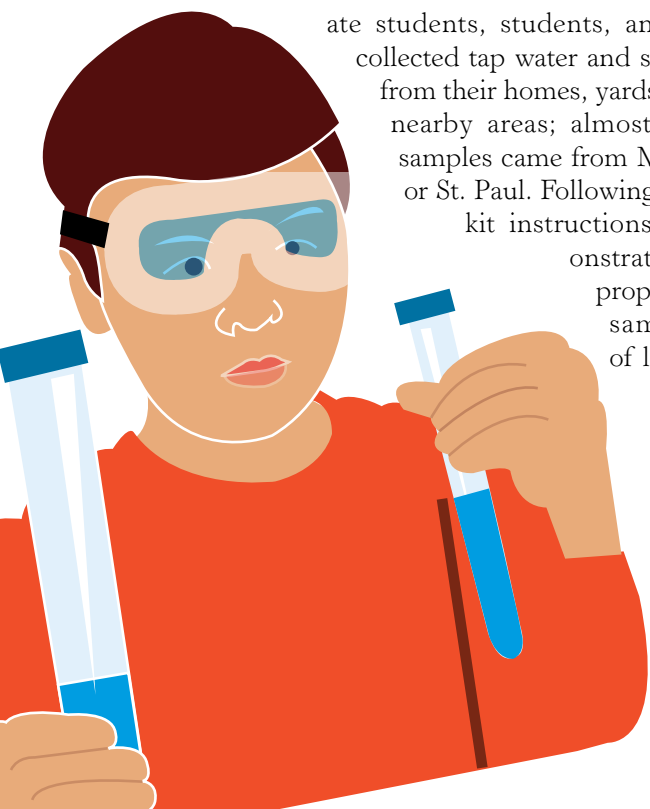
Graduate students led the students in activities, research, and discussion that focused on pollution,

environmental contaminants, and their impacts on organisms, including humans. These topics related to the graduate fellows' scientific expertise.

Students first received instruction on contaminants and environmental degradation via documentaries and current events, such as a weekly "Science in the News" lesson where we discussed science-related news items with an emphasis on pollution. Through short lectures we identified some common sources of environmental contaminants. For example, copper and lead can erode from old plumbing. Other substances, such as nitrogen and phosphorous found in fertilizers, can be introduced to the water supply as a result of runoff from agricultural areas. Even though lead-based paint and leaded gasoline are no longer commercially available, lead from these sources can be incorporated into soil. Also, lead-based paint may still be present in older homes and pose health risks when it becomes airborne (sanding, chipping, etc.).

We explained the possible effects of some common contaminants on humans and the environment. For example, exposure to lead can reduce IQ. Short-term exposure to high levels of many of the compounds found in drinking water, such as nitrate and sulfide, can cause unpleasant taste or gastrointestinal disturbance. While levels of nitrate that exceed EPA guidelines are rare (about 2.5%), its presence in about 57% of well water nationwide indicates contamination by human activities. Sulfide is usually the result of naturally occurring bacteria and rarely causes problems other than a rotten-egg smell and taste. Exposure to even low levels of copper or cyanide can cause severe damage to major organs, neurological effects, and disruption of basic biological processes.

Next, attention turned inward to examine the condition of our own environments. The graduate students, students, and teachers collected tap water and soil samples from their homes, yards, and other nearby areas; almost all of the samples came from Minneapolis or St. Paul. Following the testing kit instructions, we demonstrated how to properly collect samples. Use of liquid water



test reagents in any classroom requires facilities for storage and disposal, safety goggles, and Material Safety Data Sheets. For teachers in regular elementary classrooms, a safer solution might be the dry water test strips.



Soil and Water Testing

Led by the graduate fellows and wearing safety glasses, students tested the water samples for contaminants and the soil samples for lead following the protocols of the testing kits (water test kit: Lab-Aids, Inc. [See Internet Resources]; lead test kit: Industrial Test Systems [See Internet Resources]). The water kit tested for the following compounds: ammonia, chlorine, chromium, copper, cyanide, iron, nitrate, phosphate, silica, and sulfide. The water kit also tested pH. The soil kit tested solely for the presence of lead. Both kits used color indicators to indicate the presence of specific compounds. Students worked carefully to avoid error or cross-contamination and recorded a positive (contaminant present) or negative result for each test. Qualitative tests are easier to perform in the classroom, more robust to minor testing errors, and less expensive than quantitative tests. That said, it is important to communicate to students that the simple presence of a compound is not necessarily bad; it is often the amount or *concentration* of the substance that can cause problems.

Chromium, copper, cyanide, iron, and sulfide were not present in any of the samples. However, silica, phosphate, nitrate, chlorine, and ammonia were present in 40% or more of the samples tested. Some of these substances, such as silica, have little to no health or environmental effects but are routinely measured in water testing (silica can clog drains).

As we reviewed our findings, we explained how some common substances, such as nitrates (including ammonia) and phosphates, have little impact on human health but are common indicators of pollution in ponds and streams. Both groups of chemicals, commonly found in fertilizers, can stimulate algal growth, which can negatively affect fish and aquatic invertebrates. Chlorine is used to kill microorganisms in our water supply. Because low levels of the compounds found in the water do not have human health impacts, we did not do further tests.

Of more concern was that 67% of the home soil samples were potentially contaminated with lead. Children can be exposed to lead in soil when they play in their yards; this exposure is particularly dangerous if they put their hands into their mouths during or after their play. Because other heavy metals, such as zinc, may also produce a positive result for the test that we used, further testing would be needed to confirm the presence of lead. The U.S. Environmental Protection Agency recommends further testing if a positive result is obtained from a lead test kit, and this was communicated to the students.

Moving Forward

Students, scientists, and teachers were all determined to use their newly acquired knowledge to take action. The club members' parents had become interested in the project as their children took water samples and questioned them about their houses ("How old is our paint, plumbing, etc.?). Students reported to their parents what substances they found in their tap water and soil. In response, many parents purchased commercial water filters for drinking water (available for less than \$30). According to filter manufacturers, such filters remove 98% of lead and, to a lesser extent, copper, chlorine, and mercury. Even though our water test did not test for lead, the presence of lead in the soil and other contaminants in the water suggests that water filters are likely to have health benefits for these families. Families also modified other behaviors: moving vegetable gardens to areas without possible lead contamination (as indicated by their tests) and repainting homes. The EPA's lead website lists other ways to reduce exposure (see Internet Resources). A simple, cheap technique for removing lead from soil is to plant sunflowers, goldenrod, fescue, or corn. These plants naturally remove lead from soils. Dead plants should then be disposed of per local ordinances for hazardous waste.

In addition to these specific actions, students demonstrated remarkable understanding of the implications of their work. Here are some of students' reflections about what they learned through their science club project.

- Now I know that there are things in the water and soil that aren't supposed to be there, and they can be harmful to us.
- I understand how important chemicals in soil and water are more than before we did the testing.
- This project changed my behavior because after I knew that my house was contaminated, my dad repainted the house. I now understand why lead is important.

Spreading the Knowledge

Based on their enthusiasm and learning from this science club project, four students presented their findings at the National Association of American Environmental Educators' National Conference in St. Paul. Their teachers and new graduate fellows will help them to find other venues to share their research, such as the school's science and technology showcase. They are also eager to address related questions, such as how levels of soil lead contamination and water contamination vary in the inner city of St. Paul and nearby suburbs, and which brand of water filter is most effective at removing contaminants.

This project is an excellent example of how school lessons and programs resulted in scientific and environmental literacy. The students in the Galtier Science Club used their knowledge to change their own and their parents'

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades 5–8

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Standard F: Science in Personal and Social Perspectives

- Populations, resources, and environments
- Science and technology in society

behavior and have become more informed citizens as a result of their research. As a society, we all benefit from such individuals employing their knowledge for informed decision making. ■

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Acknowledgements

This project was funded by National Science Foundation grant DGE-0440517 (KSO, PI).

Resources

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

Powell, D.L., and V. Stewart. 2001. Children: The unwitting target of environmental injustices. *Pediatric Clinics of North America* 48(5): 1291–1305.

Internet

Lab Aide Testing Kit

www.lab-aids.com

Lead Testing Kit

www.sensafe.com

U.S. Environmental Protection Agency, Office of Water

www.epa.gov/ow

U.S. Environmental Protection Agency, Lead in Paint, Dust, and Soil

www.epa.gov/lead