

# Surveying Safety

## How researchers addressed safety in science classrooms in Wisconsin

**S**AFETY IS AN ESSENTIAL INGREDIENT in all facets of our lives and is especially important in today's sociologically complex and demanding educational settings. Tort law and professional standards are the best protective measures, helping provide students with a safe learning environment. The *National Science Education Standards* states "Teachers of science must know and apply the necessary safety regulations in the storage, use, and care of materials used by students. They adhere to safety rules and guidelines that are established by national organizations such as the American Chemical Society and the Occupational Safety and Health Administration (OSHA), as well as by local and state regulatory agencies. They work with schools and districts to ensure implementation and use of safety guidelines for which they are responsible, such as the presence of safety equipment and appropriate class size. Teachers also teach students how to engage safely in investigations inside and outside the classroom" (National Research Council, 1996, 44). Informed science education professionals should follow professional guidelines, especially those involving the safety of minors.

In 1995 and 1997, research showed that science education professionals did not have a command of essential safety information. They were dangerously lacking in understanding of applicable laws, codes, and standards. Many were also working in labs with substandard facilities and equipment (Gerlovich, 1995; 1997).

The Wisconsin Department of Public Instruction became very concerned when preliminary assessments of teacher understandings of safety issues were con-

ducted at the 1999 Wisconsin Society of Science Teachers (WSST) annual meeting. Results indicated that Wisconsin teachers had a poor command of responsibilities listed in federal and state laws, codes, and standards.

Wisconsin is similar to 25 other states that have their own interpretations of the federal OSHA regulations (such as Right-to-Know, Laboratory Standard, Chemical Hygiene Plan, and Bloodborne Pathogens legislation). Generally, OSHA regulations automatically apply to all private schools, but they may or may not apply directly to public schools. In nearly all states, the regulations apply only to employees and their employers, not to students.

In late spring of 1999, the Wisconsin Department of Public Instruction initiated discussion of a comprehensive science safety plan for all Wisconsin secondary science teachers. A three-phase program was developed to enable comprehensive training and tools for these teachers. Phase 1 was an assessment of safety conditions in science laboratories and classrooms. Phase 2 was a series of in-services that focused on safety training and tools. Phase 3 was a state-wide chemical clean sweep of unwanted chemicals.



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## PHASE 1: ASSESSMENT OF SAFETY CONDITIONS

During the summer of 1999, specific Wisconsin safety laws, codes, and standards were researched, and a training program, including content, training sites, and dates, was developed. Tort law, federal and state OSHA legislation, administrative codes, and fire, electrical, plumbing, and architectural codes were researched. In addition, applicable science teaching professional standards were examined. Finally, one-day training programs were planned for the six WSST regions throughout the state during the fall 1999 semester.

Pre-training assessment instruments were developed and mailed to teachers interested in the program, and all participants were required to return the assessment forms. The surveys measured the condition of secondary school science facilities, safety equipment, and teacher understanding of safety procedures (see online extension). Evaluation instruments developed in Phase 1 were administered following each in-service to assess the day's training effectiveness in Phase 2

From a survey of approximately 210 Wisconsin secondary school science teaching facilities, we know that, although 49 percent of schools are 21 years or older,

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more than 42 percent are less than 10 years old. Apparently many older buildings are being replaced, or new science rooms are being added in existing or growing districts within the state.

### EVALUATING THE LABORATORY

The National Science Teachers Association (NSTA) recommends that student enrollments in science labs be limited to 24, and a minimum floor space of 45 ft<sup>2</sup> per student be provided. In lab-classroom combination settings, the floor space is expanded to a minimum of 60 ft<sup>2</sup> per student (Biehls et al, 1999, 11-12). From our research, we know that 59 percent of the responding Wisconsin school labs are less than 1000 ft<sup>2</sup> and thus should accommodate a maximum of 22 students (1000 ft<sup>2</sup> divided by 45 ft<sup>2</sup> = 22.2). Slightly more than 29 percent of the labs are less than 750 ft<sup>2</sup>. In these situations, a maximum of 17 students could be accommodated safely (750 ft<sup>2</sup> divided by 45 ft<sup>2</sup> = 16.7). Only 17 percent of the participating Wisconsin lab-lecture combination rooms could accommodate 24 students (60 ft<sup>2</sup> times 24 = 1440 ft<sup>2</sup>).

On a positive note, only 29 percent of Wisconsin school science labs participating in this project did not have a functioning exhaust hood. Three-fourths (76

percent) of the teachers, however, did not know how many turnovers of air per hour their hood and ventilation systems could provide. This is very dangerous when using some types of chemicals and can severely limit labs that can be safely performed. Labs should be capable of 4 to 12 turnovers of room air per hour depending on the nature and hazards associated with the chemicals being used (OSHA Title 29).

Better than 70 percent of the participating secondary school science labs had one or fewer outward opening lab doors. Depending on the age of the building, and building codes, two outward opening lab doors are generally required for science labs. Such exits facilitate the rapid evacuation of labs during emergencies and allow alternatives should primary exits be blocked.

On another positive note, nearly 84 percent of the labs analyzed were equipped with master shut-offs for gas and electrical equipment. Teachers were advised to review the location of such equipment to be certain they could access them during emergencies.

An increasingly common, yet disturbing, trend is that science rooms are being used for non-scientific purposes. This situation was allowed in nearly 40 percent of the labs involved in this project. Not only can this be dangerous to students and untrained teachers, it can be expensive when delicate equipment is abused.

The majority of responding science teachers had adequate storage for equipment (79 percent), chemicals (70 percent), and flammables (68 percent). These are positive indicators of safety consciousness.

According to a survey of the science equipment status among the participating Wisconsin secondary school science departments, less than 62 percent of the electrical outlets in the participating schools' science settings either did not have ground fault interrupters (GFIs) or ground fault circuit interrupters (GFCIs), or the teachers did not know the status of such essential electrical safety equipment. Only 38 percent of the participating schools had the necessary GFIs. As a general rule, all water pipes within arm's length of an electrical appliance should be GFI/GFCI protected. It is disconcerting that 9 percent of labs had no ABC triclass fire extinguishers. However, more than three-fourths of the labs had at least one such extinguisher, with 18 percent having two or more.

Another worrisome statistic was the fewer than 18 percent of the participating teachers' labs that had no fire blankets available. This would be especially dangerous if a student were involved in a fire near the head or face, where using a fire extinguisher would be inappropriate. It was encouraging that more than three-fourths of the labs had at least one fire blanket, and more than 5 percent had two or more.

### EYE ON EYE SAFETY

Nearly 18 percent of the labs in the participating schools did not have a functioning eyewash station, while more

than three-fourths of them had at least one unit. About 5 percent had two or more of these strategic safety items. More than 80 percent of the teachers had American National Standards Institute (ANSI) approved eye-protective equipment. Slightly more than 14 percent, however, did not. Just more than 5 percent did not know if their equipment was ANSI approved.

Typical of most states, Wisconsin also requires eye protection for teachers and students when necessary. Generally, this is enforced by the Department of Education. The Wisconsin Safety Eye Protective Goggles statute (State of Wisconsin, 1995) states, in part:

- Every student and teacher in schools, colleges, universities and other educational institutions participating in or observing any of the following courses is required to wear appropriate, industrial quality, eye-protective goggles at all times while participating in or observing such courses or laboratories as vocational, technical or industrial arts shops, or chemical or chemical-physical laboratories involving exposure to chemical, physical, or combined chemical-physical laboratories involving caustic or explosive materials, hot liquids or solids, injurious radiation, or other hazards not enumerated.
- Eye-protective goggles may be furnished for all students and teachers by the institution, purchased and sold at cost to students and teachers, or made available for a moderate rental fee and shall be furnished for all visitors.
- "Industrial quality eye-protective goggles" means devices meeting the standards included in the American National Standards, Practice for Occupational and Educational Eye and Face Protection, 287.1-1968, and subsequent revisions thereof, approved by the American National Standards Institute.
- The Department of Education shall prepare and circulate to each public and private educational institution in this state instructions and recommendations for implementing the eye safety provisions of this section.

In Wisconsin, ANSI-approved eye-protective equipment must be used. These items are identified with a Z87 and/or the manufacturer's trademark stamped on the lens or faceplate. This means the equipment will not break or burn under normal lab conditions.

On a positive note, more than 65 percent of the participating teachers' labs had at least one approved first aid kit. Unfortunately, that means that nearly 35 percent did not. Part of the reason for the lack of such kits



was the uncertainty concerning what is appropriate for the kits' contents.

In general, kits should not contain anything to which students could foreseeably react (soaps, cleaners, antiseptics, disinfectants, and so forth). By the same token, Right-to-Know, Bloodborne Pathogens, and Chemical Hygiene legislation dictates that teachers must be able to respond to reasonable emergencies that occur in their labs. In addition, they should be able to respond to accidents (cuts, chemical splashes, objects in the eyes, burns, and so forth) that occur. It is best to consult a physician for recommendations on the contents of first aid kits.

More than 54 percent of the participating teachers' labs did not have a chemical cleanup kit. If a commercial kit is unavailable, it is reasonable to use an inert material that absorbs and contains chemical spills. Kitty litter (dried clay), vermiculite, or a similar agent works well in this capacity. The cleanup material should be kept dry and in a labeled container where it can be quickly accessed.

## MEASURING AWARENESS

According to a survey of Wisconsin secondary school science teachers, there is a great deal of variability in teacher responses to questions about essential safety procedures. A little more than 53 percent of the teachers never received science safety training, while nearly 10 percent received their training more than 10 years earlier. With the *National Science Education Standards* (National Research Council, 1996) demanding inquiry-based science for all students, this can be dangerous. Combining the lack of contemporary training with overcrowded labs and classrooms, poor equipment, and challenging students, the potential for accidents increases significantly.

Only 27 percent of the teachers knew that students wearing contact lenses may be allowed to work with caustic chemicals in labs only if they are wearing non-vented, ANSI-approved safety goggles. Slightly fewer

than 11 percent of teachers said that students would never be allowed to wear contact lenses when working with chemicals in their labs, while 62 percent said that students would have to wear safety glasses.

In April 1994, OSHA published its Personal Protective Equipment for General Industry Standard (OSHA, Title 29), clarifying this issue. Part of the preamble stated: "OSHA believes that contact lenses do not pose additional hazards to the wearer, and has determined that additional regulation addressing the use of contact lenses is unnecessary. The Agency wants to make it clear, however, that contact lenses are not eye-protective devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses." Numerous other professional organizations have taken the same position on eye protection and contact lenses.

Nearly 40 percent of the participating teachers did not have a procedure for chemical purchasing and management. This can be very dangerous when untrained personnel have access to chemicals that could easily be misused. Under Right-to-Know legislation, Wisconsin science teachers must be aware of chemical

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hazards within their work environment, properly store and label chemicals, have appropriate Material Safety Data Sheets (MSDSs) on hand, and be trained in the proper use of the chemicals.

Nearly 38 percent of the participating schools stored chemicals in alphabetical order or some system other than by chemical family/compatibility. This can be very dangerous due to synergistic reactions between adjacent items. Storing items by compatible families greatly reduces the chances of such reactions occurring.

More than 37 percent of the participating teachers did not have an approved procedure for the proper disposal of unwanted chemicals. The combination of this with the fact that only 57 percent had a copy of their district chemical hygiene plan was a formula for danger. The Wisconsin Chemical Hygiene Plan requires that plans be put into place to help reduce human exposure to hazardous chemicals in the work environment. If there is no plan for chemical disposal, compliance with the Wisconsin Chemical Hygiene Plan intent becomes very difficult. This situation became even more complicated because more than 57 percent of the participants had chemicals of which they wanted to dispose.

It was commendable that 55 percent of the science facilities in the participating schools checked their science facilities annually for safety hazards. The remaining 45 percent either did not perform such procedures, at least annually, or did not have the knowledge or tools to do so.

## PHASE 2: SAFETY TRAINING AND TOOLS

From the information collected in Phase 1, a software program was designed and customized to meet Wisconsin educational requirements (Gerlovich et al, 1999). All information on the software program was interactive, allowing science teachers to customize and print information as desired. The software encompasses the safety components of the Standards; legal aspects (laws, codes, and professional standards) of science teaching; safety management (forms and checklists for facilities, equipment, and techniques); and a chemical management database for storing, managing, and assessing chemicals.

During the fall of 1999, six day-long, in-service programs were conducted in the six WSST state regions. The morning portions of the training programs were dedicated to increasing teacher understanding of applicable federal and state laws and codes as well as professional standards. The afternoons were spent in computer laboratories becoming familiar with the Wisconsin science safety software. Post-training assessments of the value of the training and customized software were administered and data compiled.

Nearly 300 secondary science teachers attended the training programs, each representing different schools from throughout the state. Post-training assessments indicated:

- The training program presenters were very knowledgeable;
- The software provided would enable them to address safety needs in their science programs;
- All teachers should receive this training and software tools; and
- More administrators should attend in the future.

Each of the participants will return to their respective schools and offer training for their peers. The compiled information has already been used by the science supervisor for the Wisconsin Department of Public Instruction to secure funding to address some of the needs identified in the study.

## PHASE 3: STATEWIDE CHEMICAL CLEAN-SWEEP

Several needs were identified in the pre-training surveys administered in Phase 1 and were reinforced by teachers during the training sessions of Phase 2 of this project. These needs included:

- Testing and upgrading facilities and equipment to recommended standards;
- Rearranging chemical storerooms according to standards;
- Purging unwanted chemicals;
- Reducing class sizes to levels recommended by professional organizations; and
- More frequent safety training.

Since the completion of this secondary science safety awareness training program, an elementary science parallel was planned and is being implemented during the spring 2001 semester. Many of the areas of emphases are parallel, including applicable laws, codes, and professional standards. A software program has been customized to meet these needs (Gerlovich et al, 1999).

Wisconsin science teachers now have the tools to assess and address safety issues within their science programs and facilities and can identify and document needed changes. They can identify chemical hazards that require attention and/or isolation from students. And they have the information needed to contact the appropriate Wisconsin agencies to address critical problems immediately. The committee that worked with the Wisconsin Department of Public Instruction now feels that teachers are sufficiently safety conscious to begin working on a statewide sweep of unwanted chemicals. This should occur over the next two years.

Having an articulated K-12 science safety philosophy and program makes science teaching more effective and safer for all teachers and students. It also enables teachers to confidently address the *National Science Education Standards* for all students through an open-ended, inquiry-based, constructivist-learning model. Offering an inquiry-based, hands-on science program in a litigious society can be a daunting task for teachers. Providing these professionals with applicable information (laws, codes, and professional standards), practical tools (facilities and equipment checklists and forms), and chemical management tools has made them more confident in addressing these demands. This plan is proving so successful that it is being applied in similar projects in Alabama, Nebraska, Hawaii, Iowa, Minnesota, New Hampshire, North Carolina, Pennsylvania, and South Carolina. ♦

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