Guidebook for Science Safety in Illinois

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Abstract:
In 1995 the Center on Science Literacy of the Illinois State Board of Education published "Guidebook for Science Safety in Illinois: A Safety Manual for Illinois Elementary and Secondary Schools" to provide the foundation for a safe classroom environment for teaching and learning science. Safety is a very important concern in science courses because students are learning new skills, working with unfamiliar equipment in close quarters, and using materials that can pose some degree of hazard. From the perspective of teachers and administrators, the understanding of regulations, best classroom practice, and facilities preparation may not have held a high priority. It was also recognized that the undergraduate training of most teachers left them unprepared to assume the responsibility for their own safety and that of their students. A partnership of high school and post-secondary science leaders along with representatives from Illinois sections of the American Chemical Society prepared a manual covering topics relevant for elementary and secondary science teachers. A statewide teleconference was held to provide additional information and serve as a forum for teachers to ask questions concerning classroom safety. The manual is accessible online at http://www.isbe.net/secondaryed/Science%20Ed/Guidebook%20Science%20Safety/science%20education.htm or http://makeashorterlink.com/?T24A22D0.

Introduction:

Seven students were burned in a flash fire involving methanol at Genoa-Kingston High School in Illinois while observing a demonstration of flame tests. This was not an isolated incident. A recent Associated Press report* estimated that at least 150 students have been seriously injured in school laboratory accidents during the last four years. The actual number of science related accidents is not known since there is central place for collection of this information.

School science accidents have been attributed to several factors: new performance-based science standards that require more hands-on work in laboratories, inadequate safety equipment in schools, and lack of adequate training of teachers. In a survey of 18 states, Jack Gerlovich, Professor of Education at Drake University, found that over half of the science teachers have never been trained in safety. Many high school chemistry teachers have primary degrees in other fields and may only have taken two years of college chemistry.

Image yourself in the role of a new high school chemistry teacher. You have a good background in the principles of chemistry and some fascinating labs and demos to interest your students in science, but are you prepared to make sure your laboratory meets current federal and state requirements for safety? Do you know what training to give your students in the safe handling of chemicals and equipment? What do you do about the unlabeled peanut butter jar with the yellow solution you found in the back of the storeroom?

The safety training of high school teachers has been sporadic. Pre-service teachers graduate from college with some knowledge of safety but often lack information on laboratory management, current state and federal regulations for safety, and other aspects of maintaining a safe environment in their schools. Post-service teachers pick up scattered information through workshops, conferences and publications.

In 1987 The Illinois Environmental Protection Agency organized a one-time statewide pickup of excess and hazardous

chemicals from high schools. This activity focused attention on the issues of the need to improve chemical storage and the desirability to substitute less hazardous materials for the hazardous substances found in many older lab books. Several well-publicized incidents involving accidents such as the one at Genoa-Kingston have also heightened awareness of the need to pay constant attention to safety.

To provide a more systematic approach to science safety, in 1995 the Center on Science Literacy of the Illinois State Board of Education published "Guidebook for Science Safety in Illinois: A Safety Manual for Illinois Elementary and Secondary Schools". The Guidebook was the product of a partnership of high school and post-secondary science leaders along with representatives from Illinois sections of the American Chemical Society. A statewide teleconference was held to provide additional information and serve as a forum for teachers to ask questions concerning classroom safety. The manual is currently accessible online at http://www.isbe.net/secondaryed/Science%20Ed/Guidebook%20Science%20Safety/science%20education.htm or http://makeashorterlink.com/?T24A22D0.

Knowledge of laboratory safety is now part of student training as specified in the Illinois Learning Standards Science Goals 13 A. (Know and apply the accepted practices of science). By late elementary school students should Demonstrate ways to avoid injury when conducting science activities (e.g., wearing goggles, fire extinguisher use). By high school students should Estimate and suggest ways to reduce the degree of risk involved in science activities and by late high school Design procedures and policies to eliminate or reduce risk in potentially hazardous science activities.

The Illinois State Board of Education has developed <http://www.isbe.net/ils/descriptors.htm>performance descriptors and resource classroom assessments to provide additional resources for the Illinois Learning Standards at ten stages of learning. These descriptors provide more refined insight to the interpretation of the standards at these ten stages which correspond broadly to grade levels. The standard which deals with the accepted practices of science (<http://www.isbe.net/ils/science/scg13.html>13A) provides detailed references to the concepts and issues of safety at each stage. Since safety is part of the final draft of these measures, teachers will have an additional incentive to seek additional training through professional development activities and argue for additional funding for science safety. By making safety an integral part of the performance-based standards, these mandates may be part of the solution to safety awareness and training rather than part of the problem.

A pilot program to reduce exposure of teachers and students in Illinois schools to hazardous substances is being conducted by the Division of Environmental Health of the Illinois Department of Public Health. In 1999 a pilot survey of hazardous substances was conducted in Springfield schools. Subsequently two collections of hazardous materials from schools were conducted in East St. Louis and in Southern Illinois. The Division of Environmental Health has received a grant to develop a model program which will provide:

Teacher training in chemical safety with the provision for receiving college credit or continuing education units ("CEUs"). Illinois has a <http://www.isbe.net/recertification/guide.htm>procedure in which beginning teachers receive "Initial Certificates" that are good for four years of teaching and not renewable. After teachers have accumulated four years of teaching experience, they will be eligible to apply for "Standard Certificates," which are valid for five years and will be renewable based upon evidence of continuing professional development. This would allow teachers to attain additional safety training which they could apply to recertification. It is proposed that this training be assessable to teachers on-line.
Training for regional superintendents.
Collection of hazardous materials from schools after teachers have completed safety training.
Assessment of the program to measure its effectiveness in ensuring a safe working environment for students and teachers.

The Guidebook is one part of the overall strategy of providing safety information to teachers and administrators. It consists of fifteen chapters which attempt to cover the range of topics a science teacher might encounter. We wanted to make the Guidebook useful for all science teachers, so sections dealing with physics and biology are included. The

following summaries show the organization and content of the Guidebook. More detailed information can be obtained by accessing the chapters online.

Content of the Guidebook:

Chapter 1: Introduction

In the introduction we created a Top Ten Checklist consisting of questions intended to give teachers and administrators a quick overview of what we wanted to accomplish in the manual and references to appropriate sections.

1. Do you understand your professional responsibilities with regard to safety issues?
2. Does your school have a written comprehensive safety plan?
3. Does your school have a functioning safety committee that has power to make recommendations?
4. Do you have a set of safety rules that students, teachers, substitute teachers, parents, and administrators understand and practice?
5. Do you regularly train students and staff in proper handling of equipment, chemicals, and emergency equipment?
6. Do you know what to do when an emergency arises?
7. Do you have a strategy for minimizing exposure and disposal of hazardous materials?
8. Are hazardous materials stored properly?
9. Do you keep accurate records?
10. Do you follow consistent standards of practice in all classes?

Chapter 2: Responsibilities

Safety is a shared responsibility. It is shared by teachers, students, administrators, and parents. Safety should be a school policy, not the policy of an individual teacher. Many of the safety standards that apply to science laboratories are applicable to fine arts and industrial arts classes and to custodians.

Chapter 3 Physical Layout of the Laboratory

A safety audit is an important tool for maintaining a safe environment in the science laboratory. A sample audit is included to help the teacher recognize any deficiencies in safety equipment. Frequent safety inspections, typically every three months, are needed to ensure that safety equipment is ready in case of an emergency. A discussion of the use and maintenance of major safety equipment follows including eyewash fountains, first aid kits, fire extinguishers, and handicap access.

Chapter 4: Classroom Strategies

Safety in the science laboratory requires common sense, preparation, and knowledge on the part of both the teacher and students. The use of unfamiliar equipment and chemicals in the science laboratory requires extra rules for behavior. Teaching students the proper way to handle materials in the school laboratory should also help them learn correct handling of chemicals found at home or on the job. Safety education must be an ongoing process and cannot be done only once during the year. Students cannot be expected to remember everything from the safety lecture given during the first week of class. Like any other activity, safety is learned only by continual reinforcement

This chapter provides guidelines for both the teacher (classroom management, demonstration guidelines, accident report, emergency phone number) and students (safety rules, contract, procedures, quiz)

Chapter 5: Legal Aspects of Laboratory Safety

One of the main topics of discussion at laboratory safety workshops is liability. Understanding the legal responsibilities of teachers requires an understanding of State and Federal laws and civil court procedures. This section provides an overview of relevant legal statutes and steps teachers can take to defend against claims of negligence.

Chapter 6: Personal Safety Provisions

Providing a safe laboratory environment involves a combination of many efforts.
In addition to proper training, procedures, ventilation, and emergency equipment, it is important to provide students and teachers with proper personal protection for working in the laboratory. Proper clothing, eye protection, and gloves are covered in this section of the manual. Since teachers also deal with cuts and other injuries that than bring them in contact with blood, a discussion of universal precautions for blood-borne pathogens was included.

Chapter 7: Safe Handling of Hazardous Materials

To help teachers understand how hazardous materials can cause injury, we included an overview of the principles of toxicology followed with some guidance for reading MSDSs. Guidelines for the safe storage of chemicals are provided. Schools are abandoning the practice of storing all chemicals in one place in alphabetical order and are organizing their materials by hazard classification.

Chapter 8: Waste Minimization Strategies and Chemical Waste Disposal

What does a teacher do with the waste generated as a result of a laboratory activity or with the yellow liquid in the unlabeled peanut butter jar in the storeroom? We have summarized some strategies for waste disposal and ways of reducing the amount of waste generated such as substituting less hazardous materials and microscaling experiments.

Chapter 9: Standard Operating Procedures

Procedures for handling laboratory equipment including common glassware and the common hazard of inserting glass tubing in rubber stoppers. Procedures are also included for less standard equipment such a centrifuges and lasers.

Chapter 10: Other Safety Considerations

Special procedures are required for science projects, handling radioisotopes, and sources of ultraviolet radiation.

Chapter 11: References for a Safety Library

Chapter 12: Model Chemical Hygiene Plan

Chapter 13: The Biology Classroom

Safety in the biology laboratory involves many of the topics discussed previously but includes the storage, use, and disposal of organisms. Since many biology classes are performing biotechnology experiments, a discussion of standard operating procedures for these activities is included.

Chapter 14: Elementary Science Safety Standards

This section discusses aspects of the science classroom that are directed to elementary science teachers.

Chapter 15: Outdoor Safety Standards

The use of outdoor activities for field work and sample collection involves some different hazards than the normal laboratory. Issues including transportation, communication, access, and emergency medical attention are addressed in this chapter.

References:

1. Where to Find Material Safety Data Sheets on the Internet

- Where to Find Material Safety Data Sheets on the Internet: http://www.ilpi.com/msds/index.html
- SIRI MSDS Index: http://hazard.com/msds/
  MSDS: http://www.mpcfaculty.net/ron_rinehart/hazmatrs.htm#MSDS
- Materials Safety Data Sheet Dictionary: http://www.umt.edu/research/files/environ/appendic.htm

2. Walt Vollands MSDS Assignment
   http://www.scidiv.bcc.ctc.edu/wv/msds.html

3. NIOSH Pocket Guide to Chemical Hazards
   http://www.cdc.gov/niosh/npg/npg.html

4. Laboratory Chemical Safety Summaries (brief summaries of properties and information for handling some common laboratory chemicals)
   http://www.hhmi.org/research/labsafe/overview.html

5. Chemical Laboratory Information Profiles (CLIPS Journal of Chemical Education)
   http://jchemed.chem.wisc.edu/hs/CLIP.html

6. Laboratory Safety Institute
   http://www.labsafety.org/about.htm

7. ChemFinder (Online database of information on chemicals with links to MSDS and other safety information)
   http://chemfinder.cambridgesoft.com/

8. Laboratory Waste Minimization and Pollution Prevention
   http://www.seattle.battelle.org/services/e&s/P2LabMan/ch01.htm

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* Experimenting with danger, CNN.com July 6, 2002. http://fyi.cnn.com/2002/US/07/06/experimenting.with.danger.ap (accessed July 22, 2002).