

Providing Safe Learning Environments

As science educators, we have the responsibility to show by example and to teach the need for safe work habits in the science classroom, laboratory, and field. To understand this responsibility, educators must have a working knowledge of federal, state, and local laws, rules, and regulations, including the actions required by you and others under these requirements. Federal and state laws are very specific about what safety requirements are to be practiced in the science classroom and laboratory, and to be followed during field investigations. Local safety codes can be acquired from the city government offices in your community. Providing a safe environment for students is not the responsibility of the teacher alone, but is shared with students, building and central office administrators, the local school board, and the community.

Conditions Affecting Safe Science Classrooms

Overcrowding and Safety

Overcrowding in science classrooms and laboratories, where equipment and chemicals are used, should be a safety concern for every teacher, administrator, and local school board. Otherwise, overcrowded conditions could result in liability problems for the school district.

Table 1

Reported Causes of Accidents in Science Laboratory Rooms

60%	Overcrowding
42%	Inadequate facilities
38%	Inadequate equipment
28%	Inclusion students

The Texas Secondary Science Safety Profile, 2001
West, Westerlund, Stephenson, Nelson, and Nyland, 2002

Researchers have found that in a standard science laboratory where students regularly conduct investigations, more accidents occur when students have less than 41 square feet of working space and when there are more than 22 students in one class (West, et al., 2001).

“The number of students assigned to each laboratory class should not exceed 24. Students must have immediate access to the teacher in order to provide a safe and effective learning environment.”

Laboratory Safety, Council of State Science Supervisors, 1991

Overcrowding that results in injury has led to charges of negligence in some states. For example, a Michigan school’s principal and a teacher were accused of negligence in the 1979 case *Bush v. Oscoda Area Schools*. The following commentary on *Bush v. Oscoda* illustrates the legal and safety problems that can result from overcrowded science classrooms.

A 14-year-old girl was severely burned when the plastic jug of alcohol she was carrying exploded. The jug was used to transport alcohol to fill portable alcohol burners in a science class. Because of overcrowded conditions, the science class was being taught in a non-science classroom. The parents sued the school district, resulting in a verdict against the principal of the school and the science teacher. The principal was found negligent for scheduling a science class in a room that was not properly equipped for science instruction. The teacher was found negligent for conducting the class in unsafe and inadequate conditions.

The correlation between the frequency of accidents and the number of students in a laboratory at one time is supported by data. According to Fuller, Picucci and Collins, 2001, these data show that accidents become more frequent and more serious as the class size increases. Similar results were documented by Ward and West in a study conducted in Texas schools.

Table 2
Distribution of Laboratory Accidents by Seriousness and Class Size

Class Size	Minor Accidents	Moderate Accidents	Serious Accidents
Under 10	100	0.0	0.0
11–20	77.8	22.2	0.0
21–30	60.0	37.9	2.1
Over 30	42.9	40.0	17.1

Ward and West (1990), and West (1991)

“Due to a lack of funding, class sizes were large. Extra desks and chairs were packed into the science classrooms. It was difficult to move from the classroom area to the lab area with so many desks. One day we had a fire drill and students hurried to get out of the classroom, pushing the chairs and desks into one another. Some students got trapped and could not get out. Others fell and chaos ensued. One of my friends broke her leg as a result of being pushed into and caught under a desk. It was only a drill, but people got hurt. I could only imagine what might have happened if it had been a real emergency.”

Reflections on Safety, Anonymous
October 3, 2000

Overcrowding and Student Achievement

There is strong evidence that correlates overcrowded public schools to decreased student achievement. Students can gain a deeper understanding of science concepts when they are able to apply science processes in a laboratory setting. However, the laboratory must be safe, and students must have adequate space to conduct science investigations and activities.

Overcrowding may force a teacher to reduce or eliminate the amount of time allowed for students to do hands-on science. In addition, it becomes more difficult for teachers to maintain discipline when they must supervise larger numbers of students.

The state's School Facilities Standards (see Appendix A) set the standards that school districts must follow when constructing science facilities. The following chart is a summary of the room size required in Texas schools.

Table 3
School Facilities Standards for Construction before January 1, 2004

Classroom Type	Elementary School	Middle School	High School
Science classroom	800 square feet/room	700 square feet/room	700 square feet/room
Science laboratory	no requirement	no requirement	no requirement
Laboratory/classroom	900 square feet/room	1,000 square feet/room	1,200 square feet/room

Table 4
School Facilities Standards for Construction on or after January 1, 2004

Classroom Type	Elementary School	Middle School	High School
Science classroom	<i>PreK–Grade 1</i> 800 square feet/room <i>Grades 2–6</i> 700 square feet/room	700 square feet/room	700 square feet/room
Science laboratory	800 square feet/room	900 square feet/room	1,000 square feet/room
Laboratory/classroom	900 square feet/room	1,200 square feet/room	1,400 square feet/room

Square footage per room is based on an elementary school class size of 22 students, middle school class size of 24 students, and high school class size of 24 students.

Safety Is Everyone's Responsibility

The following (through Administrator Responsibilities) is adapted from *Science Laboratory Safety and Chemical Waste Disposal for Texas Science Teachers*, Texas Education Agency, 1990.

Science Students

Science students should not expect the teacher to shoulder the entire responsibility for a safe learning environment in the science classroom and laboratory. Each student should contribute to the safety of others and help maintain an atmosphere of safe learning by accepting a few basic responsibilities.

Student Responsibilities

1. Read and study the science activity or laboratory investigation before coming to class.
 - Ask questions about the activity before beginning the exercise.
 - Identify and understand the hazards and necessary precautions you need to take.
 - Understand the concept of the investigation, and know how to proceed with the investigation.
2. Know and follow all safety rules prior to the first investigation.
 - Read, understand, and sign the safety contract.
 - Wear the appropriate protective equipment, such as goggles and laboratory aprons.
 - Tie back long hair to keep it away from chemicals, open flames, and equipment.
 - Tie back or remove articles of clothing or jewelry that could touch chemicals or flames during investigations.
 - Wear shoes that enclose the feet—no sandals or open-toe shoes.
 - Never eat or drink anything while in the laboratory.
 - Locate the safety equipment, such as the eye/facewash station, and know how to use it correctly.
3. Be alert in the laboratory. Watch for potential problems, and report unsafe situations immediately. Do not work alone in the laboratory.
4. Do not attempt unauthorized activities. Work only on authorized activities that are related to the investigation.
5. If a chemical spill occurs, report it immediately and follow the teacher's instructions.
 - Move quickly from the site.
 - Wash off chemicals that have splashed onto the skin or clothing for 15 minutes using large amounts of water in the safety shower or eye/face wash station.
6. Keep your area clean. Clean up the area at the end of the class. Dispose of biological and chemical waste properly.
7. Do not enter preparatory or equipment storage rooms or chemical storerooms.
8. Always wash your hands for at least 20 seconds with soap and warm water before leaving the laboratory.

Science Teachers

Classrooms and science laboratories may be crowded, increasing the probability of accidents. Advance planning and preparation is one of the best safety practices a teacher can use to reduce the probability of accidents.

Teacher Responsibilities

1. Understand each science laboratory or field investigation in advance.
 - Carefully read and scrutinize all investigations and activities for safety procedures and materials the students will be handling.
 - Read and understand the information on Material Safety Data Sheets (MSDS) related to chemicals or other hazardous materials that will be used in the laboratory (see Appendix F).
 - Seriously consider all the hazards discussed in the MSDS and determine if the chemicals are safe for students to use. Consider substitute chemicals or use microchemistry procedures.
 - Do a trial laboratory experience if you have not done the investigation before.
 - Remember, teachers and students must wear safety goggles and protective clothing when appropriate.
 - Anticipate what could go wrong during a typical laboratory experience, and take measures to reduce the probability of an accident occurring.
2. Have regular prelaboratory activities before taking students into a laboratory setting. Go over all safety precautions in the investigation, and answer questions and concerns before beginning the activity.
3. Develop a student safety contract and keep signed copies on file.
4. Label all chemicals correctly and clearly.
5. The materials to be used during the laboratory investigation should be labeled correctly, arranged carefully, and placed in a safe area for students to use.
6. Maintain order and discipline during the activity. Safety rules are to be obeyed by all students.
7. Monitor the laboratory room or field site. Work with students to correct any procedure or behavior that is not safe.
8. Students should promptly clean up their areas *while wearing safety goggles*. Chemicals and biological wastes should be disposed of correctly.
9. Participate in an emergency response team to monitor safety and respond to accidents.
10. If accidents do occur, follow the school district's policy and guidelines on administering first aid and reporting the accident. Do not wait to write a report of what caused the accident, injuries, action taken, and results. A more accurate description can be made soon after an accident occurs.
11. Participate in ongoing safety professional development.

Science Supervisors and Curriculum Coordinators

The science supervisor and curriculum coordinator should work closely with chairpersons and lead teachers on the science safety program and serve as a liaison between central administrators and school campuses. Most of the responsibilities related to safety are those of the science supervisor. The science supervisor should conduct annual safety professional development and provide safety updates to the science teachers regularly.

Supervisor and Curriculum Coordinator Responsibilities

1. Assist the science chair and lead teacher on each campus with meeting the requirements of the Hazard Communication Act (see Appendix A).
2. Monitor all laboratory facilities for required safety equipment. The safety equipment needs to be installed correctly and function properly. An annual check of each campus, including chemical storerooms and preparatory and equipment rooms, should be part of the routine tasks.
3. Work with the campus science chair and lead teacher to review science laboratory and field investigations for safe practices and safe use of materials. Consider alternate investigations in cases where existing conditions might compromise safety.
4. Require an annual chemical inventory for each campus. Material Safety Data Sheets must be kept on all chemicals in the science department work areas.
5. Discuss with teachers the school district's process and procedure for properly disposing of chemicals and biological waste. Teachers should be made aware of their obligation to follow designated procedures for chemical waste disposal.
6. Be well informed of the laws, rules, and regulations concerning safety, and conduct professional development on safety.
7. Become active in state and national science organizations for access to current safety information.
8. Establish annual safety professional development for new teachers and review district safety policies.
9. Attend professional development on safety.

School District Administrators

A school district’s administrators, whether on the campus or in the district’s central offices, have a crucial role in assuring that students and teachers work and learn in an environment that is safe.

Administrator Responsibilities

Develop a district safety policy, and provide a safety program that includes

1. implementing the school district’s safety program;
2. supporting professional development on safety;
3. developing emergency procedures for responding to accidents;
4. ensuring that science classes do not have more than 24 students and do not exceed the number of work stations in a laboratory room;
5. providing laboratory facilities that comply with the Commissioner’s Rules Concerning School Facilities (see Appendix A);
6. providing necessary safety equipment, such as eye/face wash stations, fume hoods, emergency showers, fire extinguishers, safety eyewear, emergency fire blankets, chemical spill kits, etc.;
7. conducting annual inspections and a maintenance program to ensure safe working conditions;
8. producing safety policies that can be adopted by the local school board and implemented on all campuses;
9. maintaining compliance with the Hazard Communication Act (see Appendix A); and
10. providing the district’s procedures for proper disposal of chemicals and biological wastes.

“The accident rate in schools is 10–50 times higher than that of the chemical industry. Research goes beyond the headlines to look at the factors that accompany school accidents, which include:

- inadequate or poorly designed working space, overcrowding, and too few work stations
- teachers with poor course work preparation
- teachers who are teaching more than two preparations at the same time
- inadequate safety training.”

Guide to School Science Facilities,
National Science Teachers Association, 1999