Chapter 4
Classroom Strategies: Sample Introductory Safety Unit

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 and practice. Clearly, students will not take safety rules seriously unless the teacher obeys and strictly enforces these rules. This chapter is an example of one way to instruct students on the importance of providing and maintaining a safe laboratory environment.

There are many other versions of safety rules, contracts, and tests. These samples are provided as only one of many possible versions that may be modified to meet local needs. The basic components of this Safety Unit should, however, be provided by all science teachers.

4.1 Guidelines for the Science Teacher

Section 4.1.1 presents some guidelines for classroom management. Guidelines for performing chemical demonstrations are found in section 4.1. Information on emergency signs is included in section 4.1.3. An emergency telephone list is provided in section 4.1.4. A sample accident report is presented in section 4.1.5.

Basic first aid procedures in case of an accident are summarized in section 4.1.6.

4.1.1 Guidelines for Classroom Management

1. **Have a set of safety rules**. Students must be informed of the rules of conduct and the proper handling of equipment and chemicals in a science laboratory (section 4.2.1; chapters 7 and 9).
2. **Use a safety contract.** A safety contract signed by the students and parents and kept on file by the teacher reinforces the importance of the rules and verifies that the teacher informed the students of the safety rules (section 4.2.2).
3. **Give a safety quiz**. A safety quiz may be given to assess understanding of safety rules and procedures and may be required before a student begins laboratory work (section 4.2.4)
4. **Reinforce safety instructions.** It is not enough to cover the rules in the first laboratory session. They must be reinforced with each laboratory period. A record of this training should be included in the teacher's lesson plan as legal proof of this additional safety instruction.1 For example, before doing an experiment using the Bunsen burner, the teacher might reemphasize the importance of fire safety and the requirement to wear safety goggles.
5. **Decorate with posters and sign**. Posters and signs are excellent ways of reminding students of safety rules and procedures. You can purchase commercial posters from scientific suppliers, but students can also design their own. This reinforces safety rules and gives them a connection with the overall safety plan. This could be a good activity when you have a substitute teacher or a shortened period.
6. **Teach proper handling of chemicals**. All chemicals pose some degree of hazard. It is the responsibility of the teacher to train students in the proper handling of chemicals

(section 7.5), to select chemicals that pose minimum risk (section 8.1.4), to reduce exposure to harmful chemicals as much as possible, to provide safe storage of chemicals (section 7.5), and to arrange for safe disposal of unwanted chemicals and chemical waste (section 8.2).

7. **Know the properties of the chemicals you are using.** Under the chemical hygiene plan, each school is required to keep a file of Material Safety Data Sheets (MSDSs) for every chemical in stock. The MSDS provides information about the physical properties, health and fire hazards, spill procedures, handling procedures, and first-aid treatment for a specified chemical. The MSDS and label instructions must be read and understood before using a chemical (section 7.2.1). Recently purchased chemicals usually have labels with a great deal of safety information, while older chemicals may have labels with very little information (section 7.5.6). Before using a chemical in the laboratory, students must be informed of its potential hazard, any special handling requirements, and disposal procedures.

8. **Consider microscale labs**. The easiest way to minimize exposure to a chemical and to reduce the volume of waste is to use the smallest amount possible (section 8.1.5). Microscale or semimicroscale laboratory experiments provide many of the same educational benefits as macroscale experiments and present many advantages. Microscale labs:

- are economical. Smaller quantities of chemicals are used and purchase price is reduced.
- are safer. Exposure to chemicals is based on the amount of the chemical distributed in the laboratory air. By reducing the amount of chemical used, the atmospheric level is reduced to safer and more pleasant levels.
- are less wasteful. The true cost of a chemical includes not only its purchase price but also the cost of disposal of the waste generated by its use.
- need less storage space. Microscale equipment and solutions can be stored in a small amount of shelf space. A shoe box can hold the solutions and equipment for an entire laboratory experiment

9. **Follow current practices**. The substitution of a less hazardous chemical in an experiment can also improve laboratory safety and minimize the need to dispose of hazardous waste (section 8.1.4). Be very cautious using older books and laboratory manuals as sources of experiments because laboratory practices have changed considerably in recent years. Do not use an experiment or demonstration that you have not tested prior to using it in the classroom.

10. **Control access to chemicals.** Access to chemicals must be strictly controlled by the teacher. Chemicals must be stored in a locked facility with limited access. Students should not have access to the chemical storeroom. Do not leave storage containers of chemicals in the classroom during an activity. Students should have access only to the chemicals and quantities needed. Do not leave chemicals accessible in the laboratory during free periods or when the room is being used by another class.

11. **Enforce safety rules**. Enforcement of safety rules is crucial. Students won't obey the rules if (1) they don't understand their purpose, (2) the rules are not followed by the teacher, (3) or the rules enforced haphazardly. Teachers need a policy for violations of safety rules and they need to follow it. The first violation may result in a warning, and the next violation may result in the student not being allowed to complete the experiment.

Some teachers have given warning slips like parking or speeding tickets for safety violations.1 The laboratory safety rules and the consequences for their violation should be posted in the laboratory.

12. **Set a good example.** Teachers need to follow the safety rules and wear required personal protective equipment, including eye protection. Special precautions are needed when doing chemical demonstrations in which the teacher is wearing eye protection and other personal protection, but the students are not. Also, to enhance their visibility, demonstrations are usually carried out on a much larger scale than laboratory experiments, thus increasing the hazard. Suggested guidelines for doing chemical demonstrations are given in section 4.1.2.

13. **Practice good housekeeping.** Both students and teachers have a responsibility to follow good housekeeping practices to prevent contamination of reagents and keep equipment and the laboratory clean (section 4.2.3).

14. **Be prepared in case of an accident**. In case of an accident, emergency procedures must be followed (section 3.2.10). The teacher should have a plan to follow and access to a telpehone and list of emergency telephone numbers (section 4.1.4).

4.1.2 Demonstration Guidelines

Chemical demonstrations are a very useful way of capturing student interest and presenting concrete examples of abstract concepts. However, demonstrations must be done in such a way that both the student and teacher are protected from possible harm. George Bodner has collected a number of examples of accidents that occurred during demonstrations that are very instructive.2 Safe demonstrations require that the teacher follow the same rules that apply to laboratory experiments. It is especially important that the teacher practice a demonstration before presenting it to a class. Use demonstrations from sources that provide information on the chemical principles involved, safety considerations, and waste disposal information. 3-6 The following guidelines developed by the American Chemical Society (ACS) for demonstrations at ACS-sponsored meetings should be followed by any demonstrator.

Minimum Safety Guidelines for Chemical Demonstrations

ACS Division of Chemical Education

Chemical Demonstrators Must:

1. know the properties of the chemicals and the chemical reactions involved in all demonstrations presented.
2. comply with all local rules and regulations.
3. wear appropriate eye protection for all chemical demonstrations.
4. warn the members of the audience to cover their ears whenever a loud noise is anticipated.
5. plan the demonstration so that harmful quantities of noxious gases (e.g. NO2, SO2, H2S) do not enter the local air supply.
6. provide safety shield protection whenever there is the slightest possibility that a container, its fragments, or its contents could be propelled with sufficient force to cause personal injury.
7. arrange to have a fire extinguisher at hand whenever the slightest possibility for fire exits.
8. not taste or encourage spectators to taste any non-food substance.
9. not use demonstrations in which parts of the human body are placed in danger

(such as placing dry ice in the mouth or dipping hands into liquid nitrogen).
10. not use “open” containers of volatile, toxic substances (e.g. benzene, CCl_4, CS_2, formaldehyde) without adequate ventilation as provided by fume hoods.
11. provide written procedure, hazard, and disposal information for each demonstration whenever the audience is encouraged to repeat the demonstration.
12. arrange for appropriate waste containers for and subsequent disposal of materials harmful to the environment. Revised 6/4/88

4.1.3 Emergency Signs

Emergency signs are available from general lab supply companies and safety supply companies.

- Post lab safety rules in a prominent place in your laboratory.
- The outside doors to chemical storerooms should have NFPA 704 hazard diamonds for the benefit of fire department personnel.
- There should be signs that clearly state that chemical splash goggles are required.
- There should be signs that indicate procedures for evacuation in case of disaster.
- Location of fire extinguishers, eyewash fountains and safety showers should be clearly labeled.
- Cabinets used to store chemicals should be clearly labeled by type of hazard (e.g. acid, flammable).

4.1.4 Emergency Telephone List

A list of emergency telephone numbers should be posted in the laboratory and by telephones in the building, including the school office.

Fire
Ambulance
School Nurse
Medical
Emergency Response Unit
Office of Chemical Safety
Illinois Environmental Protection Agency
1-800-782-7860 (24 hour)
(217)-782-3637 (DIRECT)
Poison Control Center 1-800-543-2022
Police
Sanitation District

4.1.5 Sample Accident Report

Name of Student _____
Address _____ Home Phone _____
Age _____
Date of occurrence _____ Time of occurrence _____
Place of Occurrence (building, room, class name)_____
Location (Check one) Activity (Check one)

lab bench demonstration
aisle regular experiment
classroom unauthorized experiment
hallway accidental contact
storeroom horseplay
other other
Cause (Check one) Body Parts Affected (Check one)
object in motion struck person face
person collided with object eyes
person fell hands, arms
clothing caught on object legs, feet
person wais caught between objects internal
chemical exposure body
overexertion
other
Describe result of accident:
Describe any damage to property:
Describe action taken:
EMS Trip Number (if transported to a medical facility) _____
Names and addresses of witnesses

_____
Name and address of supervisor at time of injury

_____
Signature of person submitting report (name, date)

_____
Signature of principal (name, date)

_____
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In case of an accident, the teacher may want to draw a diagram on the back of the accident report to show the location of the incident and the position of the teacher. Polaroid pictures can be used to show layout of the room. The EMS trip number can be obtained from the paramedic if transportation to a medical facility is required.

4.1.6 First Aid

Toxic substances in science labs can enter the body by inhalation of gas, vapor, or particulate matter (dust), by skin contact, by eye contact, by ingestion, or by injection. Injection of chemicals usually occurs from cuts by broken glass contaminated with hazardous chemicals. The first step is to try to identify the toxic substance and call for medical assistance. Keep calm at all times and prevent shock. Immediately notify the principal, the school nurse, and the parents.

- **inhaled poisons**- (symptoms: central nervous system problems like dizziness or headache)

1. Carry the victim to fresh air if possible. Open doors and windows to ventilate the room.
2. If the victim is not breathing, trained personnel should begin artificial respiration, but do not inhale the victim's breath.

- **ingested poisons**

1. Maintain the student's breathing.
2. Collect a sample of the poison.

- **skin contact**

1. Wash away the chemical with large amount of water as quickly as possible. Continue to flush the area for 15 minutes.
2. Do not attempt to neutralize unless specifically approved by medical personnel.
3. Apply a sterile dressing.

Remember, toxic substances spilled on clothing often cause delayed and more severe problems than direct skin contact. Remove contaminated clothing before washing skin with water. Remove shoes if they will get wet from the drench so that chemicals do not wash into the shoes.

- **eye contact**

1. As quickly as possible, begin thoroughly washing the affected eyes, eyelids and face for 15 minutes. Assign someone to assist the person in washing his or her eyes.
2. If the student is wearing contact lenses, remove them if possible. If no eyewash fountain is available, use a rubber hose with a shower attachment or use cups of water.
4. If the injured person is lying down, gently hold the eyelids open and pour water from the inner corner of the eye outward. Do not allow the chemical to run into the other eye.
5. In the case of an alkaline burn or any other serious eye injury, immediately send for an ambulance so that first aid will not have to be discontinued during transport to medical facilities.
6. In the case of a minor injury, cover the eye with a dry, clean dressing. Caution the victim not to rub the eye.

- **heat burns**

1. Apply clean, cold, moist towels. Do not use ice or salt water. Continue as long as the pain persists
2. Apply a clean, dry dressing. Do not break blisters or remove dead skin. Do not apply ointments or creams.

- **electrical shock**

1. Disconnect the power source or pull the victim away using a dry wood stick or dry cloth. Make sure the rescuer has dry hands and is not standing in water. Do not use any metal or touch the victim directly
2. Maintain the victim's breathing.
3. Treat for shock symptoms (cover with blanket, elevate feet).

- **bleeding**

1. Put gloves on.
2. Apply firm pressure to the wound using a clean dressing.
3. Do not disturb the forming clot. Add additional layers of clean dressing.
4. Treat for shock.