Safety Equipments and Students' Effective Learning in Technical School Laboratories

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Abstract

The introduction of rigorous science curriculum requires the coupling of science curiosity with safety awareness. A person need not be advanced in science to understand the importance of safety in science laboratories. Thus, the creation of a culture of laboratory safety requires a broad commitment from all levels of the educational institution. This study intended to evaluate the overall status of safety equipment and student effective learning in technical school laboratories in Akwa Ibom State. It is concluded that what constitutes a safety practice in a science laboratory should never be subjective and that it is very important to emphasize that safety is about learning how to carry out laboratory work safely and not only about rules and regulations, hence students are required to think about responsibility for safety in the conduct of their work. One of the recommendations was that faculty and staff must be leaders in safety: teaching safety to students, continuously promoting safety, demonstrating the importance of safety through their actions, and accepting responsibility for safety.

Key words: Safety Equipments, Effective Learning, Technical School Laboratories, Students.

Introduction

A landmark for students' success in advanced science courses is acquiring good laboratory safety habits early in their academic journey. The ability of any country to produce well-qualified scientists with a solid background in science requires the implementation of a science curriculum that fosters scientific enquiry and engages students in practical experience meeting the needs of the society throughout all levels of education (Wrightson et al., 2008). Science laboratory courses are typical examples of such curricular requirements. Ong, McLean and Greco (2012) assert that unfortunately, working in a science laboratory in general and a chemical one in particular is often associated with the potential exposure to hazardous materials or unhealthy situations and the risk of occurrence of accidents (Young, 2003). Creating and ensuring a safe and healthy learning environment in a school laboratory setting and preparing students who are productive, respectful, and easily supervised who would avoid participating in dangerous activities in lab have become a major concern and priority for many schools (Bradley, 2011). The intricate multifaceted life we live requires us to pay particular attention to safety issues (Gerlovich, Rarsa, Frana, Drew and Stiner, 2002). Again, this is particularly true in the increasingly highly demanding middle and high school science curriculum, which leans toward fostering hands-on, inquiry-based laboratory investigation, and exploration for students who probably have not been trained on safety practices before becoming engaged in lab activities (American Chemical society, 2001).

According to Young (2003), safety plays an important role in schools and colleges. Ensuring pupil and student safety has been part of the ethical framework for decades. Schools also have legal responsibilities for safety and it is an integral part of the Ofsted framework. Like other public services, schools and colleges are adapting to a period of considerable change as well as continuing to meet existing challenges. There are new structures and accountabilities, additional parental/public/political concern, alongside worries about excessive risk aversion. There is a new understanding of the benefits of risk-taking as part of young people's development. Safety education and integrating 'risk' within the curriculum is key to these challenges.

The establishment of an academic institution that provides students with a safe learning environment could be achieved by observing or implementing relevant protective measures such as tort laws and professional standards and by adhering to safety rules and guidelines set by national organizations such as the Occupational Safety and Health Administration (OSHA), American Chemical Society (ACS), and the National Science Teachers Association (NSTA) as well as by other local and state regulatory agencies (Gerlovich, 1997). Laboratory safety and health problems became apparent after the passage of the Occupational Safety and Health act of 1970 which led to the establishment of the Occupational Safety and Health Administration (OSHA) in the following year. OSHA regulations provide direction for the protection of all personnel and facilities in most, if not all, fields of industry and academia and the establishment of OSHA has, in fact, led to more understanding of the risk in a work environment. Since the inception of OSHA, several laws and regulations have been enacted on federal and state levels that require schools to take precautionary actions in order to minimize hazards, harmful exposure, and injuries in any school laboratory and mandates the keeping of an accurate record of accidents in these laboratories (Nord and Howard, 2007). Investigating the status of science safety in secondary schools by Gerlovich et al. (2008) has led to the unequivocal conclusion that significant safety concerns existed in schools, especially with respect to age and condition of the facility, class size and area, lack or regular testing or complete absence of essential safety equipment, the inconsistent observation of most standard safety procedures by school teachers, and unfamiliarity of science educators with a number of vital and pertinent science safety laws, codes, and standards.

Statement of the Problem

The teaching of science in the nation's schools has progressed far beyond what existed even a few years ago. With the constant pace of progress and discovery in the scientific fields, school districts across the country are constantly being challenged to keep up with these advances, adding them to their science curricula both academically in the classroom and practically in the science and chemistry laboratory. However, in many districts, comprehensive laboratory safety procedures and programs are either nonexistent, out of date, or not judiciously followed, which increases the risk of accident or injury to all involved. This shortcoming can also place the potential liability for such incidents squarely upon the school or school district which failed to develop, update, or fully implement these vital guidelines.

Laboratory Rules and Safety Measures

As in all activities, safety in handling of chemicals and apparatus in the laboratory is the responsibility of every laboratory user. There is a set of rules which should be observed when carrying out experiments in the laboratory. No experiments should be performed in the laboratory without following proper procedures (Young, 2003). In additional to laboratory rules, all of those involved in performing experiments in the laboratory must be aware of some safety measures. The development of a robust system of sharing chemical laboratory safety information and practices should be a necessity for any school district. Involved parties should continue their efforts to make academic laboratories much safer places with fewer accidents and injuries (American Chemical society, 2012). To this end and as mandated by the OSHA, a chemical hygiene plan (CHP) is established and a chemical hygiene officer is appointed in every academic institution (Young, 2003). Another vital requirement is conducting safety training sessions on the hazards of chemicals present in the laboratory. The ACS recommends that two intertwining requirements be met in order to control the hazardous characteristics of chemicals and consequently prevent, or at least reduce, the likelihood of accidents in school laboratories. These two requirements are knowledge and the habit of safety. Knowledge entails gaining the necessary information about any chemical before, during, and after using it. These three phases are technically called storing, handling, and disposing of chemicals. This information can be obtained mainly by reading labels, studying Safety Data Sheets (SDS's), consulting a supervisor or a chemical hygiene officer, and by taking a comprehensive training course in safety at the time of an employee's initial assignment. According to the American Chemical society (2001), acquiring the habit of safety entails the practical implementation of knowledge and taking precautions in order to prevent accidents and/or responding to an accident. The list of safety habits includes, but is not limited to, the use of personal protective equipment (goggles, gloves, lab coats, etc.) by lab attendees at all times, handling chemicals in hoods, installing and familiarizing oneself with the use of essential laboratory safety equipment, such as fire extinguishers, eye wash, safety shower, and fire blankets. In fact, a lot of researchers argue that the nuts and bolts of safety can be learned in a science laboratory because a lot of students do not have the opportunity to learn them at home or in other classes in school and because capricious and careless actions are completely prohibited in the laboratory (Ong et al. 2012).

Furthermore, researchers argue that students can be active participants in advanced science classes if they acquire safety habits early on in their academic life (American Chemical society, 2001). In the process of developing laboratory safety policies and procedures, schools and teachers should be provided with the necessary materials and assisted by qualified individuals who possess the skills required to carry out this task (Cotman, 2000; Ong et al. 2012). In his comments on the state of laboratory safety, David Rainer (2012) notes that academic institutions are expected and probably required to review and upgrade their laboratory safety programs due to any current laboratory accidents and the "recent enforcement actions" that have been put in place. He also argues that the notion that academic institutions do not enforce lab safety in their campuses, as perceived by the media, might be only half the truth because some schools do offer rigorous safety training, do require students to take safety classes (both for- and not-for-credit) and do ultimately impose serious penalties on violators of safety rules and standards. The following list summarizes some of the responsibilities and measures that should be assumed or taken to assure the creation of a full-bodied safety culture in a school science laboratory (Rainer, 2012).

- Having safety leadership
- Identifying and providing safety orientation for new personnel
- Having safety training sessions
- Assessing hazards before an experiment
- Putting in place plans a chemical hygiene plan
- Ensuring availability of laboratory clothing and individual protective equipment
- Conducting laboratory inspections and personal assessment
- Providing laboratory users with emergency information

Similar points were pointed out Ashbrook (2013) who said that researchers agree on the following: the safety vision of a school is driven by the safety vision of its administration and training teachers to be role models for safety practices constitutes one of the most basic elements of the creation of a positive safety culture in schools (Hill Jr. and Finster, 2013). They also agree that the creation of a “Safety Culture” should be an on-going high priority for school districts. The districts should assemble a safety training program for their staff and students and should also develop a system for implementing the program through mandatory safety lectures and orientation, distribution of self-study materials, and necessitating the passing of a safety test in order for students to register for a science class. Organizing periodic workshops for teachers to share their safety practices might also prove helpful (Kennedy and Palmer, 2011). One of the possible and probably compelling approaches of reviewing an institution’s policy on safety and analyzing the level of adherence with lab safety rules is surveying parties involved in safety issues such as school administrators, teachers, and students.

Special Safety Considerations in Academic Laboratories

According to Ashbrook (2013), academic laboratories, like industrial and governmental laboratories, are concerned with meeting the fundamental safety goals of minimizing accidents and injuries, but there are differences. Forming the foundation for a lifelong attitude of safety consciousness, risk assessment, and prudent laboratory practice is an integral part of every stage of scientific education—from classroom to laboratory and from primary school through postdoctoral training. Teaching and academic institutions must accept this unique responsibility for attitude development.

Ashbrook (2013) asserts that resources are limited and administration must provide support for teachers who are not subject matter experts. The manifold requirements for record keeping and waste handling can be especially burdensome for overworked teachers in high school or college laboratories. Institutions with graduate programs teach, but they also conduct research activities that often involve unpredictable hazards. The safety goals and the allocation of resources to achieve them are sufficiently different for secondary schools, undergraduate, and graduate teaching laboratories

High school teaching laboratories

Laboratory safety involves recognizing and evaluating hazards, assessing risks, selecting appropriate personal protective equipment, and performing the experimental work in a safe manner. Training must start early in a scientist career. Even a student's first chemical experiments should cover the proper approach to understanding and dealing with the hazardous properties of chemicals (e.g., flammability, reactivity, corrosiveness, and toxicity) as an introduction to laboratory safety and should also teach sound environmental practice when managing chemical waste. Advanced high school chemistry courses should assume the same responsibilities for developing professional attitudes toward safety and waste management as are expected of college and university courses

Academic research laboratories

Ashbrook (2013) stated that advanced training in safety should be mandatory for students engaged in research, and hands-on training is recommended whenever possible. Unlike laboratory course work, where training comes primarily from repeating well-established procedures, research often involves making new materials by new methods, which may pose unknown hazards. As a result, workers in academic research laboratories do not always operate from a deep experience base. Thus, faculty is expected to provide a safe environment for research via careful oversight of the student's work. Responsibility for the promotion of safe laboratory practices extends beyond the EHS department, and all senior researchers—faculty, postdoctoral, and experienced students—should endeavor to teach the principles and set a good example for their associates. The ability to maintain a safe laboratory environment is necessary for a chemist entering the workforce, and students who are not adequately trained in safety are placed at a professional disadvantage when compared with their peers. To underscore the importance of maintaining a safe and healthy laboratory environment, many chemistry departments provide laboratory safety training and seminars for incoming graduate students. However, in many cases these sessions are designed to prepare graduate students for their work as teaching assistants rather than for their work as research scientists.

Cotman (2000) opined that formal safety education for advanced students and laboratory personnel should be made as relevant to their work activities as possible. Training conducted simply to satisfy regulatory requirements may seem like compliance, and researchers may sense that the training does not have the leader's full support. EHS offices and researchers can work together to address such concerns and to design training sessions that fulfill regulatory requirements, provide training perceived as directly relevant to the researchers' work, and provide hands-on experience with safety practices whenever possible. Safety training is an ongoing process, integral to the daily activities of laboratory personnel. As a new laboratory technique is formally taught or used, relevant safe practices should be included; however, informal training through collegial interactions is a good way to exchange safety information, provide guidance, and reinforce good work habits.

The Role of the School in Laboratory Safety

Stroud (2007) asserts that the development, implementation, and enforcement of school laboratory safety programs are the responsibility of the individual school districts. When a science curriculum is developed, an integral part of that development should include comprehensive safety and health instruction as a first step in practical instruction in the laboratory. While the Federal Government does not require that students be given safety and health instruction, it does require that employees (teachers and assistants) be given this training. Some individual states have recognized the need for a formal laboratory safety program for students and do require that state guidelines be followed and that students receive training similar to that required by the Federal OSHA statutes.

Teacher responsibility

Teachers are next in the chain of responsibility, as the first line of contact for students in the laboratory; they are the most important link in this chain. By carefully instructing students in the safety procedures to be followed, familiarizing them with the laboratory equipment, the proper handling procedures for chemicals to be used, and by providing adequate supervision during every stage of the learning process, teachers have the most influence on their students to ensure the successful and safe outcome to practical laboratory experiments. There are safety policies, practices and procedures for the technical teacher to follow in the school shop.

- Identity and control hazardous conditions
- Provide appropriate facilities for storage, handling and transport of hazardous substances.
- Ensure that all accidents (major or minor) are reported.
- Promote safety practices among students
- Inspect the workshop regularly and make corrections to minimize or eliminate hazards.

Ensure that only authorized and properly trained students are allowed to operate equipment etc.

Student responsibility

Finally, it is the responsibility of the students in the laboratory to follow the guidelines and safety procedures taught to them to improve their learning. While the students may come from a wide variety of backgrounds that may prepare some of them for the responsibilities of the lab, others may not have any experience in such activities or predilection to follow such strict guidelines. It must be impressed upon them that their safety and success depends upon carefully following procedures and adequate time must be set aside to ensure that all are thoroughly familiar with, and motivated to follow, these steps prior to beginning the experiments. In itself, the training is a good start towards establishing a firm step by step procedural foundation that the students may build upon to prepare for and enhance their experience in the laboratory.

Students are expected to adopt or comply with all workshop safety rules, practices and procedures. They should:

- Report all accidents to their instructor
- Not to use any faulty tool or equipment
- Obey all safety rules and regulations
- Take instructions from the instructor (Mbaba, 2001).

Muhammed (2010) maintained that safety precaution in the school workshop involves regular inspection of the environment, machines and their immediate repair when found out of order.

Division of Tasks in the Laboratory

According to Puyate (2001), there is a distinct division of duties and responsibilities between instructors and students in the laboratory. The instructors are responsible for the planning, preparation, instruction, and execution of the practicum while providing adequate supervision during all phases, ensuring adherence to the guidelines of the instruction, and maintaining a safe learning environment for all. The task of supervision and leadership to ensure the safety of students is probably the most critical factor while performing school laboratory experiments (Puyate, 2001).

The duties of teachers and aides may include, but are not limited to:

- Proper maintenance and operation of laboratory and safety equipment and facilities,
- Proper administrative records keeping and training documentation,
- Identification of possible hazards or hazardous situations that may exist,
- Instruction for participants in safety procedures and emergency action plans,
- Knowledge of and familiarity in the use of safety and emergency equipment,
- Knowledge of the location and operation of critical shutoffs for systems such as gas, liquid, and electricity,
- Proper storage, documentation, and monitoring of chemicals stored in the laboratory,
- Ensuring order and adherence to procedures in the laboratory while experiments are underway.

Students also have responsibilities in the lab. It is critical for them to understand that serious incidents can occur if proper attention is not paid to their experiments, or if their conduct causes an accident with the equipment or chemicals. Safety must be paramount in all of their actions while in this environment. Student responsibilities may include, but are not limited to:

- Proper and safe behavior in the lab
- Knowing and following all applicable safety and health guidelines
- Following standard, established laboratory and chemical handling procedures
- Ensuring that their work stations are kept neat, free from clutter and properly cleaned
- Wearing the proper clothing and safety equipment while in the laboratory
- No eating, drinking, or smoking in the lab
- Properly dispose of all chemicals and broken glassware
- Knowing all emergency and evacuation procedures

Personal Protective Equipment (PPE) and Effective learning In Building Technology

The individual can be protected in the school workshop through the correct use of Personal Protective Equipment (PPE). Okoh (2000) stated that there are various kinds of PPE used in the school workshop to enhance skill training in Building Technology. The above can only be achieved if students are properly trained on the use of appropriate PPE for their job.

Puyate (2001) added that the protection of the individual in the school workshop through the use of PPE should be considered only as backup activity and not a correction or substitute for elimination of the hazard. PPE should be considered as a protective clothing, because it will create an undue feeling to safety in workshop when it becomes ineffective without the knowledge of the user. He stretched that whenever a decision is made to employ protective equipment, those selecting the equipment should examine them critically. They should consider the follow criteria:

1. The extent of hazards potential to cause harm must be evaluated.
2. The extent of the expected protection is in direct proportion to the seriousness of the hazard.
3. The cost of the equipment.
4. The quality of the equipment.
   The protective ability of the equipment to interfere with the students' performance in the shop (Yakubu, 2004).

Some of the safety equipment used in the school workshop are:

a. Eye goggles: used for protecting the eyes.
b. Apron or coveralls: used for protecting the body.
c. Safety boots: used for protecting the feet.
d. Safety helmets: used for protecting the head.
e. Hand gloves: used for protecting the hands.
f. Face shields: used for protecting the face and throat.

Effective learning in Building Technology

The aim of skills acquisition in Building Technology is not merely to produce academic personnel, but to prepare the individual for greater societal responsibilities in areas such as sustainable economic growth and nation building. Skills are acquired when theoretical knowledge is translated into practical activities. Skills acquisition as the name implies is the ability to learn a skill (Udo, 2010). Peretomode (2004) explained that a skill can be vocational skill, technical skill etc. Manipulative skills are important for the training of students, because is the ability to use tools effectively in performing ones job. Manipulative skills are also known as soft skills. Soft skills are personal attributes that enhance individual's interactions, and career prospects.

Building technology, in Technical Colleges, need students with high technical and manipulative skills and the ability to relate with others. It is imperative that the Building Technology students in the Technical Colleges should be trained on the necessary Technical and manipulative skills.

The Technical Colleges graduates are trained to acquire employable skills to get them employed in the Building industry to enable them remain on the job with ability and effectiveness in job performance. These skills are relevant to be acquired for a productive work force. These acquired skills give the technical graduates an opportunity to secure and maintaining different kinds of employment. It also depends on whether one is able to fulfill the requirements of specific jobs.

Conclusion

Creating a culture of safety in an academic institution requires a combined effort of many entities. It is concluded that what constitutes a safety practice in a science laboratory should never be subjective. This major step in the study involved identifying problems and suggesting solutions or making recommendations to improve the status of safety equipment in schools labs. It is very important to emphasize that safety is about learning how to carry out laboratory work safely and not only about rules and regulations, so students are required to think about responsibility for safety in the conduct of their work. Thus, working safely is a basic responsibility of every employee and every student.

Recommendations

The following were recommended:

1. Faculty and staff must be leaders in safety: teaching safety to students, continuously promoting safety, demonstrating the importance of safety through their actions, and accepting responsibility for safety.
2. Laboratory safety education and training is an ongoing process and therefore should be integrated into every laboratory course
3. A departmental safety committee should be established if it does not exist to ensure that regulations are followed by others and to reduce unnecessary risks.

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