

Difficulties and Solutions of Laboratory Safety Education in Colleges and Universities

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Abstract

Laboratory safety education is an important element of the lab safety management system and an important means of the risk management and control of labs. Focusing on enhancing the level of lab safety education, we will strengthen the safety and occupational health education of lab personnel by constructing a three-level safety education system, faculty team, and expanded educational channels that consists of ‘school-department-laboratory’, and improve lab safety and environmental protection awareness. In addition, we will promote scientific improvement of the lab safety management and risks control in colleges and universities.

Key words: Laboratory safety education; Teaching resources of education; Education system; Course design

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Laboratory is an important base for education and scientific research in colleges and universities, the place of talents cultivation and training, a key link in innovative achievements, and an important platform for experimental education. The comprehensive reform of colleges and universities, together with the construction of “double first-class” universities, has greatly promoted the

development of higher education and enhanced the overall level of university labs. And lab safety education has become urgent. Due to the storage of hazardous chemicals, special equipment, equipment with high temperature and pressure, radioactive isotopes, and radiation devices, labs are extremely prone to accidents such as explosions, fires, toxin leakage, electrical injuries, radiations, and mechanical damages that directly threaten the safety of teachers and students and even cause social instability in severe cases. In recent years, many lab accidents had occurred in universities around the world. The poisoning case of Shanghai Medical College of Fudan University in April 2013, the explosion happened in the He Tian Building of the Chemistry Department of Tsinghua University in December 2015, and the lab explosion of the Municipal Environmental Engineering Department of Beijing Jiaotong University in December 2018 all indicate that the lab safety education has become crucial in colleges and universities. An effective implementation of the lab safety education not only requires teachers and students to know the concept of lab safety, but also requires them to understand the risks and the prevention and safety measures of hazardous chemicals, special equipment, pathogenic microorganisms, radioactive isotopes, and radiation devices from a professional perspective. This can help teachers and students to master the lab safety knowledge and improve their ability to effectively prevent and respond accidents. In addition, lab safety education for corresponding majors can help students learn about hazards and occupational health regulations in the related fields and help improve their prevention and safety measures of accidents. It will effectively improve students’ professional abilities, occupational health awareness, and environmental awareness. We can comprehensively cultivate talents that meet the needs of professional requirements and social development. Although lab safety education in Chinese universities has been vigorously implemented along

with the approval of the comprehensive reform plan for higher education, it is still in its infancy; and professional safety education and occupational health education for lab hazards and hazardous experimental techniques are seriously lacking. Further improving the safety education system and methods of labs in colleges and universities has become an important research topic.

1. CURRENT STATUS OF LABORATORY SAFETY EDUCATION

Recently, lab safety education in colleges and universities has developed rapidly under the promotion and supervision of the Ministry of Education. Laboratory safety education and emergency drills have received extensive attention. Taking Tsinghua University as an example, lab safety education consists of 24 courses, including general education, chemistry, biology, radiation, electromechanical and emergency. Moreover, universities including Zhejiang University, Sichuan University, Chongqing University, East China University of Science and Technology, have offered 0.5-2 credits elective courses of school-level lab safety education and professional ones for majors such as chemistry, biology, and medicine. However, lab safety education is still lacking in many colleges and universities across the country, especially in the northeast, northwest, and southwest region.

1.1 Insufficient Teaching Resources for Lab Safety Education

Compared with the lab safety management system of the Environmental Health & Safety (EH&S) Department (Huang & Ai, 2018; Zhang, Wu & Ma, 2020; Wei, You & Huo, 2012) and the safety education of faculty adopted by European and American colleges and universities, the same education is often neglected in our domestic schools. Most of the lab staff are part-time employees with an overall low educational background. Most of the staff have little knowledge and are indifferent in environmental protection, health and safety improvement of the workplace and working conditions, and maintaining the legal interests of experimentalists. This directly prevents the effective implementation and long-term development of lab safety education. In addition, lab safety education and management has yet to be included in the hiring, assessment, and evaluation process in most colleges and universities. Thus, it is difficult to cultivate personnel with adequate safety knowledge and proficient professional skills as the main force of lab safety education in the management team.

1.2 Laboratory Safety Education Is not Included in the Educational System

Due to the limited class hours in the current college education program (Yao, 2019, pp.47-48), the lab safety education presentations in schools can hardly make

teachers and students fully understand of the danger of lab hazards, key points of self-protection, the correct contingency measures, and the complete lab safety system. This has seriously affected the improvement of their safety awareness.

1.3 Insufficient Laboratory Safety Education Content

Most of the lab safety education courses emphasize on accidental scenarios involving fire, water, electricity, public security, and anti-theft. Risks of hazardous chemicals, special equipment, and radiation, biological and other hazards, and experimental techniques are neglected. Occupational health education and emergency drills related to experiments are rarely mentioned or performed. And this shows an inadequate content for lab safety education (Du, Feng, & Zhang, 2018).

1.4 Evaluation and Assessment of Lab Safety Education Need Improvement

The evaluation and assessment of lab safety education is still missing in the majority of colleges and universities though they have greatly promoted the establishment of lab safety management and responsibility systems and have formed the general evaluation system. The effective implementation and sustainable development of lab safety education cannot be achieved through the general update of the safety management system in schools without the support of systematic, institutionalized, and standardized education and evaluation systems (Yu, et al, 2020, pp.295-307; Xiong, Peng, & Liu, 2018, pp.296-299; Li, Huang, & Ai, 2019, pp.248-253).

2. DIFFICULTIES IN LABORATORY SAFETY EDUCATION

2.1 Difficulties in Improving the Lab Safety Education Level

Laboratory safety work in colleges and universities involves many professional fields, which belong to specific occupational categories. Personnel engaged in education should systematically master professional safety knowledge and skills and continuously improve their level of education and practice. However, the current lab personnel can only rely on self-study to explore and learn about the lab safety; additionally, the safety supervision environment and working conditions of provinces and cities differ significantly. As a result, it is difficult for lab personnel to learn about lab safety and industry standards in a timely, effective, scientific, and accurate manner, which greatly restrains further education of lab safety and makes it more difficult to enhance the lab safety education level.

2.2 Difficulties in Expanding Channels for Lab Safety Education

An ideal way for professional and systematic lab safety education should include course lectures, supplemented

by presentations and cultural activities co-organized by the schools, departments, and laboratories. However, due to the limited amount of course hours for college students regulated by the training system, it is extremely difficult to include those courses in the training program. Most of teachers and students are not interested in lab safety presentations and cultural activities organized by schools because of their relative weak awareness of lab safety. The participation rate of such activities is generally very low, which severely retrains the expanding of lab safety education channels.

2.3 Difficulties in Supporting Policy and Resources

Laboratory safety education in colleges and universities involves many aspects of work and requires coordination among the schools, departments, and laboratories. However, relevant rules and regulations in colleges and universities are incomplete. The assigned responsibilities of units is ambiguous, which is obstructive to the implementation of lab safety education. The lab safety assessment is imperfect, and the corresponding hierarchical and classified safety education and evaluation system cannot be established. More importantly, the incentive supporting policy for the implementation of lab safety courses and creation of such culture atmosphere is lacking in colleges and universities. Meanwhile, funding to support the staff team and resources for the implementation of lab safety is still lacking. It is difficult to promote the enthusiasm of lab safety staff.

3. SOLUTIONS TO THE DIFFICULTIES OF LABORATORY SAFETY EDUCATION

3.1 Improve the Concept of Lab Safety Education and Establish a Linked System Among 'School-Department-Laboratory'

The purpose of lab safety education in colleges and universities is to improve teachers' and students' awareness, focus on health protection of lab personnel, reduced environmental pollution and damage, and promote future development of lab safety education. This requires teachers and students to fully recognize and understand the importance of lab safety, in addition to the common accidental scenarios caused by fire, water, electricity, and public security. Colleges and universities should establish a linked system for safety education that consists of general safety education at the school level, professional safety at the college level, and experiment safety at the lab level. The school should organize and conduct general education on lab safety, the college should take the characteristics of majors into consideration when organizing safety education for specific professions or majors. It should also include safety information about hazardous chemicals, radioactive isotopes, radiation

equipment, lab animals, pathogenic microorganisms, and lab waste in the safety education and activities. The lab should focus on safety training on specific equipment and experimental techniques used. This 'three-level' linked system for safety education is interdisciplinary, progressive, and complementary. It can effectively teach the lab personnel the general and professional safety knowledge that is required and ensure the safety of personnel and lab property. It will help deepen the concept of 'safety, health, and environmental protection' in the mind of teachers and students. And it closely associates the training of professional talents with the needs of the industries (Jin, Ma, & Ke, 2018, pp.4-8; Zhu, Ma, & Xiong, 2019, pp.50-52; Liu, Yang, & Wang, 2015, pp.31-34; Han, et al, 2019, pp.245-249).

3.2 Evaluate Lab Safety Risks and Form a Hierarchical and Classified Safety Education Course Plan

The implementation of lab safety education course in colleges and universities is an effective way to break the bottleneck of safety education in higher education. A specialized, standardized, and sustainable implementation of lab safety course is the way to solve the issues in improving the safety education level in schools. Evaluation of the safety risks in colleges and departments and lab safety education course plans based on the evaluation will promote the implementation of these courses in schools and departments, which, in return, ensures the actual implementation of safety education courses. Taking Southwest University as an example, based on the usages of hazardous chemicals, lab animals, pathogenic microorganisms, special equipment, radiation devices and radioactive isotopes, as well as the annual lab safety hazards report, the lab safety management department evaluates the safety risks of each department, and a hierarchical and classified safety education course plan is formed based on the results.

Table 1
Laboratory Safety Education Course Plan of Southwest University

Type	Risk level	Course type	Course credit
Natural science I	High	Major core	≥0.5
Natural science II	Mid	Major elective	≥0.5
Natural science III	Low	Major elective & general elective	≥0.5
Humanities, social sciences, arts, and sports	Low	General elective	0.5

According to the lab safety education course plan, the implementation in Southwest University is as follows:

- a. The major core and major elective courses of lab safety education are organized by the department according to the plan and are open to all undergraduate students within the department.
- b. The general elective courses of lab safety education are organized by the lab safety management department

and are mainly open to students of colleges with low-risk level and selected students of colleges with mid-risk level.

3.3 Build a Platform for Online Lab Safety Education Using Information Technology

There are limited channels for lab safety education in colleges and universities, but the schools need to evaluate the personnel safety access review program in the lab safety management system and include safety education

in the administrative requirement that personnel must pass the lab safety exam. The schools should take advantage of information technology to implement the lab safety education and exam system so that lab personnel can master lab safety knowledge while obtaining access, and the schools can achieve their goals for safety education on campus (Feng & Zong, 2015, pp.245-248). The workflow of lab safety education and exam system of Southwest University is shown below.

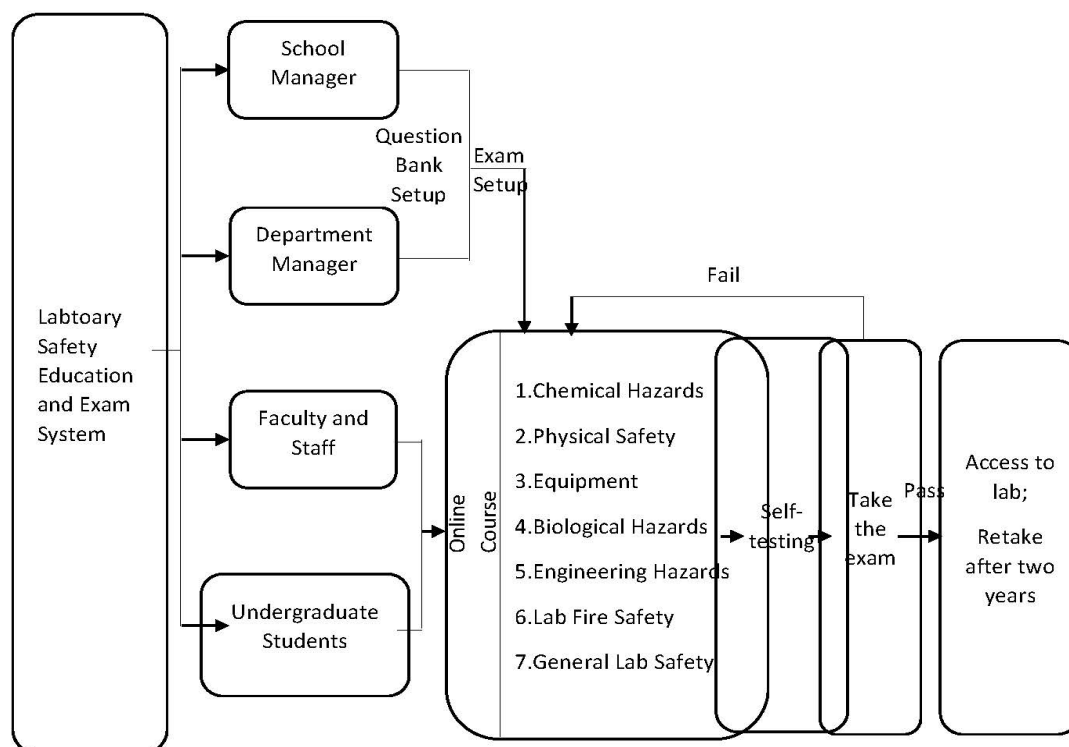


Figure 1
Flow Chart of Laboratory Safety Education and Exam System of Southwest University

Students can learn the lab regulations and safety through online safety course and exams. There are 3022 sets of exam that include questions from seven categories: chemical hazards, physical safety, equipment, biological hazards, engineering hazards, lab fire safety, and general lab safety. Students can test their knowledge through online tests and practice exams and proceed to the safety exam once they are ready. Students who pass the exam will obtain the lab safety education and training certificate and access to lab for experiments and research.

4. CONCLUSION

As an important supporting platform, the lab is expanding rapidly with the development of disciplines in colleges and universities. At the same time, the types of hazard waste in lab and the dangers of experiments are growing fast. The safety education of lab personnel has become one of the most important tasks of lab safety risk management and control. Colleges and universities should focus on enhancing the safety education level and

establishing a linked system of ‘school-department-lab’ for safety education. They should expand the faculty team, resources, and educational channels to achieve safety education for all majors, for all personnel (students and staff), and at all time.

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