

Research on Effective Methods of laboratory Safety Education for college students

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Abstract: Safety is the primary condition for laboratory work. University laboratories are important places for scientific research, and safety education in university laboratories is a key measure to implement the source management of laboratory safety, which requires multiple measures and comprehensive implementation^[1]. Research has found that local university laboratory safety education has problems such as insufficient ideological attention, weak sustainability of safety education, improper educational methods, and insufficient teaching staff. Policy suggestions have been put forward to ensure the safe operation of local university laboratories by emphasizing and systematically thinking about the layout of laboratory safety education, optimizing educational methods, and strengthening various guarantees.

1. INTRODUCTION

The development of science cannot be separated from experiments. University laboratories are important places to explore new knowledge, consolidate new skills, and enhance students' comprehensive qualities. With the expansion of undergraduate enrollment scale, the increase in teaching tasks, and the continuous expansion of laboratories, the types and quantities of experimental equipment and materials are gradually increasing. At the same time, potential safety hazards and risks in laboratories are becoming increasingly prominent. Many new situations and problems will arise in the management and use of laboratories, leading to frequent laboratory safety accidents such as fires and explosions, resulting in a series of serious consequences such as casualties and property losses. Laboratory safety and environmental protection work is facing enormous pressure and challenges. How universities can strengthen safety education, improve the effectiveness of safety education, prevent accidents, and ensure laboratory safety is an important topic worth exploring and researching.

2. ISSUES RELATED TO LABORATORY SAFETY EDUCATION IN UNIVERSITIES

2.1 Low awareness of safety and insufficient emphasis on safety education

In recent years, the country and government departments have called for strengthening safety education in university laboratories, effectively increasing the importance of laboratory safety education in universities.

In 2015, the Ministry of Education carried out safety inspections of university laboratories, organized experts to conduct on-site investigations and put forward suggestions. The inspected universities were required to rectify the suggestions and provide supporting materials. In May 2019, the Ministry of Education issued the "Opinions on Strengthening the Safety Work of University Laboratories", requiring universities to implement "all staff, comprehensive, and full process" safety education, in order to achieve the effect of "brain to heart" in safety education. In February 2023, the Ministry of Education issued the "Safety Standards for Laboratories in Higher Education Institutions", providing clear guidance on the safety work of laboratories in higher education institutions. However, through observation and research, it has been found that there are still some local university leaders, relevant departments, and students who do not attach enough importance to safety education, have insufficient guarantees, and have lax system implementation^[2].

2.2 Safety education has formalization, weak targeting, and single methods

There is a formalized approach to safety education that requires inspection, neglects the process, and does not focus on practical results. On the one hand, the Ministry of Education has clearly defined the content of safety education inspections in the list of laboratory safety inspection items, and some universities use this as a benchmark to carry out safety education for inspections and traces. On the other hand, some universities' laboratory safety education admission work needs further improvement, such as not providing comprehensive learning materials and only releasing question banks for brush based learning; The exam questions are single,

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mostly based on single choice subjective questions, with less objective questions designed; There are many instances of others taking the exam as substitutes or failing to pass the exam, resulting in less effective safety education^[3].

Some universities in some places do not have strong relevance in conducting laboratory safety education, and adopt the method of offering public elective courses. Regardless of the college, major, or grade, relevant teachers use unified courseware for teaching. However, students majoring in science, engineering, medicine, and even humanities have different needs for laboratory safety education due to their different professional attributes, and their acceptance ability also varies, resulting in poor training and education effectiveness. For example, biochemical laboratories should focus on the training of various knowledge, physical and chemical properties, and first aid measures of dangerous chemicals, while humanistic laboratories should focus on the training of fire and electricity prevention, computer virus prevention and other knowledge.

The method of safety education is single. Most local colleges and universities conduct theoretical lectures, invite experts to give lectures, and play videos, with relatively few adopting methods such as safety practice, scenario simulation, and emergency training. Some universities have established a laboratory admission system, and students must pass safety knowledge exams to enter the laboratory. However, in the actual implementation process, there are lax checks, loose exam standards, and even the phenomenon of proxy exams. Some universities have conducted safety exercises, but due to limitations in venue, funding, and time, student participation is insufficient. Some students only stay at the level of "watching the excitement", and if a similar crisis occurs, they are still at a loss and unable to cope with it.

2.3 Imperfect safety education mechanism and insufficient practical training

The purpose of laboratory safety education is to enable students to learn and correctly apply safety knowledge and skills, while laboratory safety educators can evaluate the effectiveness of laboratory safety education, establish effective mechanisms, and ensure the safe conduct of experiments. At present, many universities have not yet established evaluation and assessment mechanisms, and schools cannot directly dismiss teachers and students in accordance with relevant standards like enterprises. Without a laboratory safety education system for assessment and evaluation, no matter how advanced, it is just "empty talk". Therefore, schools should consider laboratory safety education as one of the important reference indicators for teacher promotion and student evaluation.

Safety education has strong practicality^[4], and only by adopting immersive, experiential, and practical teaching methods can better teaching results be achieved. However, practical teaching resources are insufficient to support the safety education principles and requirements

of "full staff, full process, and comprehensive", mainly reflected in the following aspects. Firstly, the coverage of students holding regular fire drills and emergency drills in universities is limited, and most students have no experience of participating in the drills; Secondly, at the level of secondary colleges and tertiary laboratories, there are few or no safety simulation exercises organized; The application of modern information technologies such as virtual simulation, virtual reality (VR), and augmented reality (AR) in laboratory safety education is still in its early stages, and further development, exploration, and promotion of applications are urgently needed^[5-6].

3 EFFECTIVE MEASURES FOR SAFETY EDUCATION IN UNIVERSITY LABORATORIES

3.1 Attach great importance to laboratory safety education from an ideological perspective

Laboratory safety workers in universities should attach great importance to the education and infiltration of safety knowledge from an ideological perspective, and pay attention to creating a safety atmosphere. American safety engineers once proposed the "Heinrich Safety Rule", which states that for every 300 violations or safety hazards, there may be 29 minor injuries or malfunctions, and 1 serious injury or major accident. We should ensure that teachers and students form the principle of "safety first, prevention first" from top to bottom. Safety education should be taught annually, monthly, and constantly, and every opportunity should be taken to promote laboratory safety knowledge. We should promote the awareness of safety first among teachers and students through methods such as conference lectures, expert lectures, video playback, posting slogans, and promotional posters.

Vigorously strengthen the improvement and implementation of the system. In some local universities, the awareness of institutional management is not strong, and there are many phenomena such as missing, lagging, and blank systems, which can easily lead to a situation where laboratory safety management has no rules to follow. Therefore, it is necessary to establish, modify, and abolish the system of our unit, to achieve the use of system management for personnel and management of affairs. Through the system, the main body, procedures, responsibilities, and responsibilities of laboratory safety management and education should be clearly defined. Strictly enforce the system, and punish teachers and students who violate the system through methods such as criticism, education, warning, punishment, and transfer from teaching positions.

Incorporate experimental safety education courses into general education courses and provide certain credits based on class hours to stimulate students' motivation to learn knowledge related to laboratory safety education. For students majoring in science, engineering, and medicine, it can be a compulsory course, while for students majoring in humanities and economics, it can be

an elective course. The course can be flexibly offered through classroom and online teaching methods to reduce the pressure on teachers in class and facilitate students to learn anytime and anywhere.

3.2 Conduct targeted training to improve laboratory safety education methods

Adopting a "general education+professional" safety education model to strengthen the targeted nature of safety education. In the content of laboratory safety courses, there should be a certain proportion of "general knowledge" module knowledge, including relevant national laws and regulations, safety and environmental protection, water and electrical use, high temperature and high pressure and commonly used equipment, emergency response to sudden accidents, laboratory waste disposal, and other common knowledge; On this basis, appropriate "professional" module knowledge should be added based on the actual situation of each profession. For example, safety education in chemical laboratories can include content such as chemical poisoning prevention, gas cylinder explosion prevention, chemical burns, laboratory "three wastes" treatment, fire extinguishers, emergency sprinklers, eye washers, and other items usage regulations.

Based on the characteristics of students, a comprehensive approach to safety education is adopted. Traditional safety education methods, such as classroom lectures, expert lectures, bulletin boards, knowledge competitions, and distributing promotional brochures, can still be adopted. Based on the characteristics of college students, making full use of modern science and technology can better attract their enthusiasm for participating in training and education. For example, in terms of publicity of security knowledge, new media such as Internet websites, WeChat official account, small video websites, Tiktok can be used for publicity; In the exercise of safety issues, VR/AR and virtual simulation technology can be used to provide students with better teaching experience and effectiveness through experiential teaching such as games and animations.

3.3 Building a "3+1+1" safety education curriculum system

3.3.1 "Core" courses (safety foundation courses, safety admission courses, and safety professional courses)

Basic Course on Safety for College Students (referred to as Basic Course). This course is a general, universal, and compulsory course offered to all undergraduate students. It is generally conducted when new students enter the school, and the course content includes traffic safety, fire safety, and laboratory safety. Laboratory safety is just one of the themes, and fire safety is commonly used for laboratory safety. Basic courses have universal characteristics. By introducing high-quality online MOOC courses for online teaching, universities with certain teaching conditions can carry out mixed online

and offline teaching. Laboratory Safety Access Course (referred to as Access Course). The curriculumization of laboratory safety admission is conducive to the effective implementation of the admission system and the enhancement of the effectiveness of admission education. The teaching object of this course is all undergraduate students who enter the laboratory for experimental learning and research activities; The teaching content is a combination of general education and professional education; The teaching method is to carry out online teaching through the construction of specialized education and teaching platforms. The admission course is open to all major students through direct examination, which means they are exempt from studying and not exempt from the exam. If they do not pass the direct examination, they should study first and then take the exam until they pass the exam; For some majors, exemption is implemented, that is, passing the laboratory safety major course and exemption from admission courses is recognized as passing. Laboratory Safety Professional Course (abbreviated as Professional Course). The teaching objectives and content design of this course should not only focus on laboratory safety and ensure laboratory safety, but also surpass laboratory safety and look forward to professional and industry safety. For the establishment of professional courses, it is recommended to offer corresponding majors (professional categories or professional groups) in Safety and Insurance Level 1 (high risk) and Safety and Insurance Level 2 (high risk) laboratories; The corresponding majors of Level 3 (medium risk) safety and insurance laboratories can be opened, and universities with sufficient resources and conditions should try to open them as much as possible; The corresponding majors in the Safety and Insurance Level 4 (General Hazard) laboratory may not be offered, and the learning requirements can be met through basic courses and admission courses

3.3.2 "Expansion" course (safety elective courses)

The higher education in the new era advocates personalized education for students, realizing their right to choose and exercise autonomy in more courses. The same is true for laboratory safety education. We encourage universities, especially those with safety majors, to adhere to the principle of "opening as much as possible" and offer more laboratory safety elective courses for all students in the school, as well as laboratory safety elective courses suitable for students in professional and professional groups. We aim to enrich and expand course resources to meet students' self-learning and self-education needs.

3.3.3 "Grip" course (experimental courses)

The experimental course is the foothold and key lever for laboratory safety. Laboratory safety content should be included in the experimental course syllabus and given priority during the teaching process. The first class of the experimental course mainly focuses on providing safety accident case warning education, popularizing the use of

fire extinguishers, and introducing laboratory safety exits and emergency escape routes. Before each experiment, safety education should be conducted, including operating procedures for experimental equipment, safety precautions during the experiment, etc. Experimental teachers should pay attention to the entire process of the experiment and promptly detect, stop, and correct students' unsafe actions. In addition, the safety literacy and performance of students before, during, and after the experiment are included in the assessment of the experimental course, and are included in the course grade according to the proportion of composition^[7].

4 CONCLUSION

Laboratory safety is closely related to the safety of teachers and students' lives and property, and it cannot be ignored. Safety education work is the first line of defense to ensure laboratory safety. To strengthen this line of defense, not only should we improve the laboratory safety education system, provide guidance and support for safety education work, but we also need to increase investment, improve laboratory software and hardware, and enhance the level of laboratory safety protection and management. At the same time, it is necessary to continuously improve the content and methods of safety education and training based on the characteristics of each university's laboratory, to ensure the effectiveness of the training.

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