

# Exploring the Construction of Laboratory Safety Education System in Double-Class Universities

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**Abstract:** Promoting the construction of "double first-class" universities is conducive to enhancing the country's educational strength and comprehensive national power, and providing a strong pillar for achieving the great rejuvenation of China. As laboratories in universities play an indispensable role in the cultivation of talents and the progress of science and technology. So, laboratory safety is particularly important. Based on the actual working experience in the workplace, the author studies how to build a laboratory safety education system, so as to provide reference for the laboratory safety management of "double first-class" universities.

**Keywords:** "double first-class" universities; laboratory safety; construction of laboratory safety education system

## 1. Introduction

The construction of "double first-class" universities is another initiative of the state in the development of higher education in recent years. The goal is to create world-class universities and world-class disciplines, and the development of higher education is obvious in China. Laboratories in universities play a pivotal role in the progress of schools and scientific and technological innovation. But laboratory safety management in universities has been a late concern. It is because universities have paid attention to the output of experimental results and ignored laboratory safety over the years. In recent years, laboratory safety accidents in universities have been frequent, causing casualties and property damage, and the casualties of highly skilled personnel have undoubtedly had an extremely bad impact on national and social development. There is an urgent need to explore the method of constructing laboratory safety education system in colleges and universities, in order to provide guarantee for laboratory safety management.

## 2. The current situation of laboratory safety management in colleges and universities

Domestic universities all undertake the teaching and scientific research tasks of the school, and the open experiments, graduation designs and course designs of undergraduates are all completed in the laboratory. Postgraduates will enter the laboratory to carry out studies as soon as they enter the school; and the safety education for entering the laboratory is often neglected. The tutors talk about the laboratory contents and the seniors train the operation process, so the probability of laboratory safety accidents is higher in universities. In December 2018, an explosion occurred in a laboratory of a university in Beijing, resulting in three students dead. In March 2021, an explosion in a reactor at an institute of the Chinese Academy of Sciences killed one person. In July 2021, a doctoral student at a college in Zhongshan was rinsing a flask when it exploded and glass fragments punctured the arterial blood vessels of his arm. In October 2021, a laboratory at a university in Nanjing burst into flames, killing two people and injuring nine others. In April 2022, a laboratory at a university in Changsha burst into flames, resulting in injuries to a PhD student [2~3]. Laboratories in colleges and universities involve electricity, high temperature, high pressure, radiation, hazardous chemicals and so on, which are difficult to manage. However, laboratory safety managers in colleges and universities not only have little systematic training, but also are severely understaffed, which makes it more difficult for laboratory safety management. In the laboratory safety inspection in universities, author also found that more than 50% of teachers and students were more "disgusted and opposed" than "cooperative and supportive" to the inspection, and some teachers who have been engaged in scientific research for a

long time said that "it has been like this for decades without any accident". The school is now strengthening its management to "target" them, and it sincerely does not want them to work in the laboratory, which is not beneficial to the development of the school.

### **3. Analysis of the causes of the current situation**

#### ***3.1 The assessment mechanism of universities disregards safety***

The assessment and evaluation mechanism of university laboratories is to see how many excellent talents have been trained, how many high level articles have been published, and how much economic value has been created for the university. The emphasis has always been on research output, and the "process" of achieving these results is not pursued. "Process" is not taken into account in any assessment or evaluation system. Therefore, laboratory safety, which is closely related to the "process", is not mentioned and not taken seriously.

#### ***3.2 Concealment of safety in university news reports***

As a result of China's unique national conditions, school news reports subconsciously minimize the impact of public opinion, and it is "customary" to reduce laboratory safety accident reports in official school reports, or to focus on eliminating negative impacts rather than learning lessons and using accidents to carry out safety education. For many years, university accidents have been reported almost exclusively as major accidents with casualties, with minor accidents such as burns and hazardous chemical leaks not appearing in the news. Zhang Sen of Hebei University said, "Every safety accident is a teaching material, we have to change our thought, change the way, turn disadvantages into advantages, turn regrets into warnings, let the accident in its the most authentic state to educate more people, and play the value of education in the whole staff. [4] "According to the famous Heinrich's law, small hidden dangers and accidents are not taken seriously will eventually become a big disaster.

#### ***3.3 Colleges and universities' investment with neglecting safety***

Most university laboratory inputs are used to purchase advanced equipment or instruments, and very little for laboratory safety. It is because the investment in laboratory safety cannot intuitively produce benefits, not to achieve immediate results, which is from long-term considerations, belongs to the preventive work. Besides, the amount of money invested varies from one university to another because of the different levels, and even some private universities do not invest anything in laboratory safety, including the most basic protective facilities, in order to reduce teaching costs.

#### ***3.4 Lack of safety awareness among teachers and students in colleges and universities***

The laboratory safety awareness of university laboratory is weak among teachers and students, and the lack of attention to laboratory safety is mainly performed by insufficient safety knowledge and poor safety habits [5]. Both undergraduate and postgraduate students do not pay enough attention to learning laboratory safety-related knowledge during their studies, and are not willing to participate in the laboratory safety education arranged by the university. Even if they do, they are forced to "go through the motions" and do not listen carefully.

### **4. Construction of laboratory safety education system in colleges and universities**

There are many reasons for the difficulty of laboratory safety management in colleges and universities. But in the final analysis, it belongs to the weakness or lack of laboratory safety awareness among teachers and students. To solve this problem, we need to build a laboratory safety education system, raise the awareness of laboratory safety among teachers and students, and actively create a good laboratory safety culture.

#### ***4.1 Develop a laboratory safety management system***

According to the characteristics of the school specialized subject, develop a laboratory safety management system that meets the school's own characteristics, and use the system as a grip to regulate the behaviour of teachers and students. The rules and regulations established by the school are also a

guide of the action for teachers and students, telling them what they can do and what is forbidden to do. The system should also contain various regulations, such as the Regulations on the Management of Hazardous Chemicals, the Regulations on the Management of Gas Cylinders, the Regulations on the Management of Hazardous Waste in Laboratories and so on, which not only regulate behaviour, but also provide operational guidelines for laboratory teachers and students. The establishment of a laboratory safety management system will make laboratory safety management "clear in terms of authority and responsibility, reasonable in terms of management and in place", laying a solid foundation for the construction of a laboratory safety education system.

#### 4.2 Create a unique laboratory safety training model

According to the survey, most of the laboratory safety training in colleges and universities now is scattered, or is the general knowledge class. All students regardless of major, regardless of grade are taught the same content, even for the teacher's training also use the same set of PPT. So, teachers and students listen to the "foggy", and over time they will create the "aversion to learning" and the acceptance of laboratory safety management naturally decreases. To do a good job in laboratory safety management training, we need to create a new model that suits the characteristics of our school. The author explores a training model based on work experience that combines in-school and out-of-school training. The training in-school should be hierarchical training for teachers and students in all aspects, and the training out-of-school is mainly for teachers with all types of training. See Figure 1 for details.

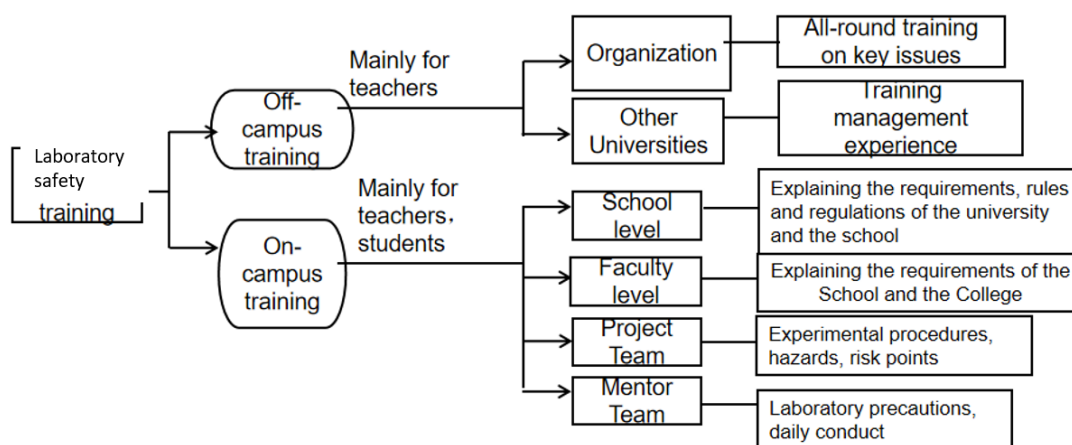


Figure 1: Laboratory safety training model

#### 4.3 Creation of a laboratory safety curriculum system

In February 2023, in order to strengthen laboratory safety in colleges and universities and ensure the personal safety of teachers and students and campus stability, the Ministry of Education issued the Specification for Laboratory Safety in Colleges and Universities [2023] No. 5, in which it was mentioned that "colleges and universities involving important sources of danger should set up credit-bearing laboratory safety courses", according to the professional characteristics of schools. The creation of a laboratory safety course system is not only a necessary tool for universities to carry out laboratory safety education, but also an explicit provision of the Ministry of Education to regulate laboratory safety management in universities. To create a laboratory safety course system, it is necessary to carry out different laboratory safety courses in different stages of study for undergraduate and postgraduate students; it is also necessary to design distinctive learning contents for different majors in order to attract students' attention and achieve learning effects.

For undergraduates, freshmen have just moved from high school to university. There are fewer experiments carried out by themselves in high school, and they all watch the teachers operate. Therefore, the first-year course focuses on awareness-raising, and can be followed by a compulsory course on Laboratory Safety. In the second half of the year, students will enter the laboratory after taking the course. However, different majors encounter different sources of danger in the laboratory. The optional course "Identifying Safety Hazards in the Laboratory" can be set up according to the characteristics of the major. In the third year, students will formally carry out the study of professional courses, and there will also be course design, all need to carry out experiments. According to the

characteristics of universities, the teacher-student ratio is seriously inadequate. Therefore, teachers cannot keep an eye on every student to carry out experiments. So we can set up "professional courses laboratory safety" compulsory course. In the fourth year, every student will be involved in graduation design or thesis. For engineering students, experiments are inevitable, and students at this stage are in the exciting period of graduation, so they need to be reminded to pay attention to laboratory safety. And a compulsory course on "Safety Skills Required for Conducting Experiments" can be set up before the graduation thesis, but it should not be too long.

For postgraduate students, the first year of study is mainly about the study of courses, but different supervisors have different research tasks and different requirements for students. The student population also varies greatly, with interdisciplinary students present every year and with varying degrees of awareness of laboratory safety. Therefore, the course in the first year of study could be to raise awareness of laboratory safety again and provide a general education with a compulsory course on "The Relationship between Laboratory Safety and Research". In the second year, when students have basically finished their courses, they will formally enter the laboratory to carry out experiments and also carry out long-term research tasks in the laboratory. At this time, the potential risks of the laboratory should be emphasized and an optional course on Laboratory Hazards can be offered at this time. Students in their third year of study carry out their graduation thesis and also face the pressure of recruitment work at a stressful time, which is also a point when safety accidents are more likely to occur. For universities, they also shoulder social responsibility, and education on social responsibility in universities involves multiple subjects [5], and laboratory safety education should also belong to one of them. If students are aware of safety after graduation and enter the workplace, they will undoubtedly be able to reduce the probability of safety accidents and reduce the loss of company (factory) property as well as social losses. Therefore it is possible to offer an optional course on "The Need for Laboratory Safety" in the third year of study.

Laboratory safety courses are offered throughout the university, with different content, different hours and different credits according to the professional characteristics of each second-level college, so as not to waste teachers and avoid students' "weakness" in laboratory safety education, as shown in Figure 2.

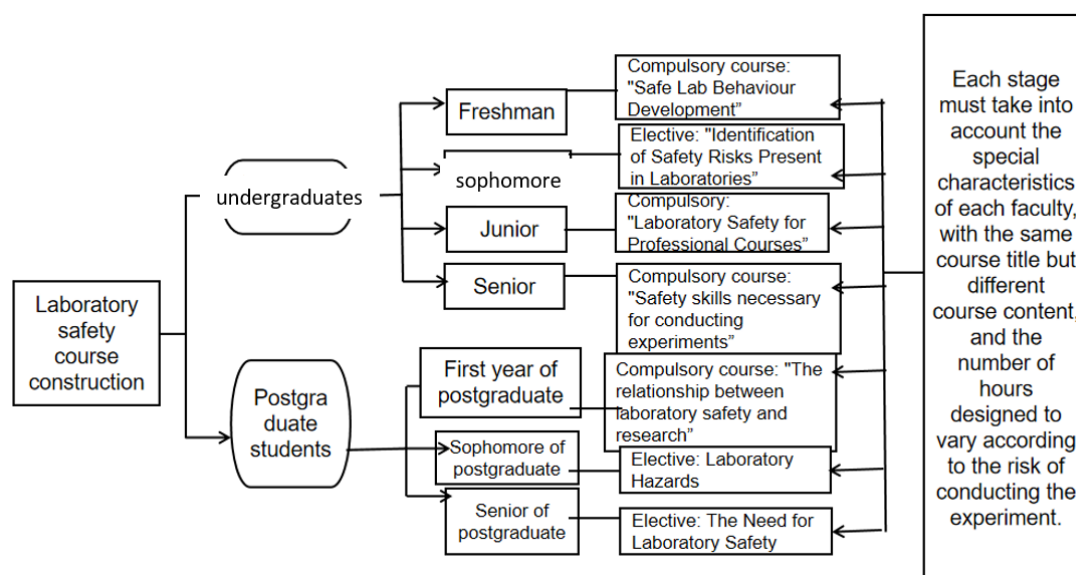


Figure 2: Laboratory safety curriculum

#### 4.4 Innovative laboratory safety cultural products

Laboratory safety culture influences human behaviour in a silent way, and safety culture products as a carrier are a very friendly way for students to receive "brainwashing" in a pleasant way, by designing safety elements into students' daily necessities, so that they can be influenced by the ear, or integrated into entertainment products, so that they can be taught and entertained [3]. Today's universities are full of post-90s and post-00s students, who like to be innovative, like to pursue freedom, do not want to be bound by tradition, easily receive new things and get rich material conditions and comfortable life. They are avant-garde thinking, enthusiasm and openness. They are cognitive level increased, active

thinking energetic, positive mindset and brave to accept challenges. As a result of the Internet has changed the inefficiency of traditional media, post-90s and post-00s become the net generation [6]. Therefore, laboratory safety education cannot be confined to the traditional sermon, but needs to keep up with the times and design relevant laboratory safety cultural products according to the target audience. For example, Hebei University has designed laboratory safety elements into playing cards so that students can learn about laboratory safety in an entertaining way; Tsinghua University has sung songs about the importance of laboratory safety and precautions so that students can learn about laboratory safety in a casual way. Universities can also design laboratory safety elements in their notebooks and distribute them to students, so that when they take notes they can also see the requirements for laboratory safety and receive the relevant knowledge implicitly. Universities can also design laboratory safety elements in their calendars, so that when they turn the pages they can feel the importance of laboratory safety at first hand every day. Similar products can be found on mobile phone wallpapers, toothpaste, toiletries, etc.

## 5. Conclusion

The position of double first-class universities in national development and university education is crucial, and good laboratory safety is a prerequisite for various achievements. Building a laboratory safety education system can effectively enhance the laboratory safety awareness of teachers and students, greatly create a laboratory safety culture and reduce the probability of laboratory safety accidents. Universities can all learn from this practice to ensure the harmony and stability of the campus.

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