Research on the Construction of Safety Culture in University Laboratories

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ABSTRACT

The safety of university laboratories is an important part of social security, and the construction of laboratory safety culture is the cornerstone of promoting experimental safety management. However, there are currently bottlenecks in the construction of laboratory safety culture in local colleges and universities, such as insufficient theoretical knowledge, weak awareness, insufficient atmosphere, and relatively single promotion. Based on the reference of laboratory safety culture construction in China and foreign countries, this article proposes suggestions to strengthen the construction of laboratory safety culture in the dimensions of ideology, individuals, collectives, and management.

Keywords: *Laboratory safety culture, University laboratories, Laboratory safety.*

1. INTRODUCTION

The safety of university laboratories is an important component of social security, and the safety of university laboratories is directly related to the safety of teachers and students. According to incomplete statistics, from 2001 to 2020, there were 113 publicly reported incidents of laboratory safety accidents in universities nationwide, resulting in a total of 99 injuries and deaths. Among numerous laboratory safety accidents, most of them are caused by weak safety awareness and insufficient safety culture construction. In the 62 comprehensive or STEM universities inspected by the Science and Technology Department of the Ministry of Education from 2015 to 2017, 100% of the schools had chemical safety management problems, including improper storage of chemical reagents and gas management, which are directly related to insufficient safety awareness and weak safety culture. Laboratory safety culture is not only about rules and regulations, but also a consensus and value recognition of laboratory safety among laboratory management personnel, teachers and students participating in experimental activities throughout the school. Therefore, strengthening the construction of laboratory safety culture plays an important role in improving laboratory safety management, reducing the incidence of safety accidents, maintaining campus safety in universities, and even overall social safety. On this basis, this article analyzes the bottlenecks in the construction of safety culture in university laboratories, and proposes suggestions and countermeasures for the construction of safety culture in university laboratories based on the reference of Chinese and foreign laboratory safety culture construction.

2. THE BOTTLENECKS OF SAFETY CULTURE CONSTRUCTION IN UNIVERSITY LABORATORIES

2.1 Insufficient Integration of Safety Theories and Weak Foundation of Cultural Construction

The lack of deep integration between safety management theory and ideological and political theory in the construction of safety culture in local university laboratories has led to a lack of systematic theoretical support for cultural construction. From the perspective of safety management theory, system safety theory emphasizes the full cycle control and dynamic risk assessment of hazards, but some colleges and universities only limit safety management to equipment maintenance and institutional wall level, without using this theory to construct a risk closed-

loop culture system. Teachers and students only passively abide by safety regulations, rather than actively internalizing safety values into behavioral norms.[1] In terms of integrating ideological and political theories, the overall national security concept requires laboratory safety to be included in the "big security" framework, but lacks top-level design that combines laboratory safety with ideological and political education and national security education, and only stays at the technical operation level.[2] Comparing Chinese and foreign universities, it is found that foreign universities such as Harvard University combine safety culture with academic integrity education to form a consensus among teachers and students that "safety is the bottom line of scientific research", while Chinese universities rely more on administrative orders to promote safety work and lack a cultural soil infused with theory.[3]

2.2 Formalization of Safety Education and Lack of Cultural Cultivation Mechanism

There is a formal problem in safety culture education, which emphasizes knowledge imparting over ability cultivation and short-term training over long-term development. Although admission training and exams are widely implemented in current universities, the content is mostly general safety knowledge and lacks subject specificity. More than 70% of safety education in Chinese universities relies on online theoretical courses, such as video learning on MOOC platforms, but less than 20% of practical training on emergency response to hazardous chemical spills and special equipment operation standards.[4] Most teachers regard safety training as an administrative task and fail to integrate the cultivation of safety habits into scientific research guidance, resulting in students imitating illegal operations in experiments. The rigidity of the assessment mechanism is insufficient, further weakening the effectiveness of education. Although the pass rate of university laboratory admission exams is high, students still engage in behaviors such as not wearing protective equipment and mixing reagents in violation of regulations when operating independently. There is a disconnect between the assessment of "passing the exam ≠ meeting the ability standard", and the safety culture has not been transformed into practical ability.

2.3 Single Cultural Activities and Insufficient Atmosphere for All Staff Participation

The design of safety culture activities lacks innovation and depth of participation, presenting the characteristics of "more administrative leadership, less teacher-student autonomy" and "more general content, less disciplinary characteristics". And the activities are mostly lectures and competitions, lacking interactivity and experiential education. Some colleges and universities rely on mandatory measures such as "inspection notifications and economic penalties" to promote safety work, leading students to view safety culture as a "task to cope with inspections" rather than an autonomous demand. The neglect of disciplinary differences further weakens the effectiveness of activities. A survey found that 72% of universities have not designed special activities for humanities laboratories (such as electrical safety and data safety in electronic information laboratories), and have uniformly applied chemical safety templates for science and engineering. This has led to some teachers and students believing that safety culture is irrelevant and their participation enthusiasm is low.[5]

2.4 Shallow Digitization of Applications, and Limited Cultural Communication Channels

Digital technology focuses on management rather than cultural communication, and its application in safety culture promotion remains at the "tool level", without fully tapping into its "cultural empowerment" value. Although Chinese colleges and universities have introduced intelligent monitoring and hazardous chemical management systems, these platforms are mainly used for risk warning and process approval, lacking a safety culture promotion module.[6] Some universities' online learning platforms have a course update cycle of more than one year and do not use AI to analyze student and teacher learning data, making it impossible to achieve personalized content recommendations.[7] This mode of emphasizing management over dissemination results in safety culture being transmitted only through one-way channels such as notifications and announcements, making it difficult to stimulate the participation and resonance of teachers and students.

3. DRAWING ON CHINESE AND INTERNATIONAL EXPERIENCE IN THE CONSTRUCTION OF SAFETY CULTURE IN UNIVERSITY LABORATORIES

In terms of theoretical integration, foreign universities focus on deeply integrating safety management theory into practice and forming a scientific management framework. Pennsylvania State University in the United States has proposed the "Three Pillars" theory of laboratory safety, namely safety culture, safety awareness, and safety training, which aims to enhance the level of safety management through a long-term mechanism that combines theory with practice.[3] Chinese colleges and universities rely on system security theory to construct a multi-level management system. Central China Normal University has established a "six in one" laboratory safety management system, covering institutional, cultural, team, facility, organizational, and information construction, to achieve the integration of theoretical framework and school-based practice.[8]

In terms of safety culture awareness, foreign universities emphasize the cultivation of "bottom-up" safety culture awareness, highlighting the student's subject status and diverse participation. MIT students spontaneously established a safety association, independently conducted training, produced safety guidelines, and formed an "active participation" management mechanism.[3] Chinese colleges and universities focus on institutional driven and management led safety culture construction. Fudan University has established a 24-hour accident reporting system, which strengthens responsibility tracing through digital means and drives the improvement of safety awareness.[9] In addition, some universities are exploring student participation mechanisms, such as Shanghai University establishing a student management team to participate in the management of laboratory safety training centers, gradually transitioning from "passive management" to "active participation".[10]

In terms of cultural atmosphere, foreign countries create an immersive safety culture through frequent and diverse activities. Harvard University holds "Laboratory Safety Day" every year, which includes practical scenarios such as fire simulations and chemical leak emergency drills, to strengthen the emergency response capabilities of teachers and students.[3] Chinese colleges and universities focus on building safety culture platforms and innovating regular activities. Tsinghua University carries out publicity through online and offline platforms such as WeChat official account and security display board to form a "three-dimensional" cultural communication matrix.[7]

In terms of cultural promotion, foreign universities use technological means to expand channels for promoting safety culture. Imperial College London has developed the Security Audit Tool (STAT), which integrates training, inspection, and feedback functions to achieve dynamic interaction of security information through a digital platform.[3] Chinese colleges and universities rely on information technology to expand the dimension of security propaganda. Shanghai University is building a three in one training system consisting of an "experience hall -training platform - experience space", combining online resources with offline practical operations to strengthen the cultivation of safety skills.[4]

4. COUNTERMEASURES AND SUGGESTIONS FOR THE CONSTRUCTION OF LABORATORY CULTURE IN COLLEGES AND UNIVERSITIES

In terms of ideological dimension, it is necessary to strengthen the integration of safety theory and enhance the theoretical foundation of safety culture. The overall national security concept is the country's overall view and understanding of security issues, and is the core and foundation of national security strategy. The overall national security concept aims to ensure the safety of the people, and social security is one of its guarantee factors. The safety of university laboratories is a part of social security and an important component of carrying the safety of university property and life. Integrating the theory of the overall national security concept into the theory of laboratory safety culture is an important ideological guarantee for laboratory safety construction. On the one hand, in the construction of laboratory culture, it is necessary to strengthen the learning of the theoretical system of the overall national security

concept, and combine relevant practical cases to enhance the understanding and application of the overall national security concept in laboratory safety management. On the other hand, it is also necessary to increase investment in theoretical construction projects for laboratory safety culture, encourage laboratory staff and all teachers and students to actively participate in the theoretical learning and promotion of laboratory safety culture. In addition, in addition to the overall national security concept theory, safety management theories such as iceberg theory, barrel theory, and system safety theory should be actively integrated into the construction of laboratory safety culture[8] to strengthen the theoretical foundation of laboratory safety culture and enhance laboratory safety management.

From a personal perspective, there is a must to strengthen the education of safety culture among teachers and students, and enhance personal awareness of safety culture. The strengthening and promotion of laboratory safety culture cannot be separated from the learning of safety culture. Safety education is the most effective way to learn safety culture and enhance laboratory safety culture awareness. The first is to strengthen the education of laboratory cultural knowledge through activities such as online learning, questionnaire surveys, and knowledge competitions. The second is to strengthen laboratory safety culture education and training. By encouraging laboratory management personnel and laboratory managers to conduct regular training courses, introducing laboratory safety culture theory and knowledge, and enhancing the safety awareness of teachers and students. The third is to strengthen the practical education of laboratory safety culture. By applying safety theory in practice, it is aimed to enhance the safety literacy of teachers and students. For example, there will be a must to establish safety culture innovation projects and safety simulation courses to enhance teachers' and students' understanding and learning of laboratory safety culture, and to improve laboratory safety culture awareness. In addition, it is necessary to strengthen the admission education for new teachers and students and enhance their awareness of safety culture. Newly recruited teachers and students lack sufficient understanding of the safety management system and regulations in university laboratories, have a lack of awareness of laboratory safety culture, and have weak safety awareness. Therefore, in laboratory safety education, newly recruited teachers and students should be given priority, and their learning of laboratory safety knowledge and awareness of laboratory safety culture should be enhanced through online SPOC courses or laboratory safety education and training.[4]

On a collective level, it is an important step to actively mobilize the participation of teachers and students in laboratory safety culture activities, and create a good laboratory safety culture atmosphere. A good cultural atmosphere cannot be separated from collective construction, and the construction of laboratory safety culture requires the investment and participation of all teachers and students in the school. The first is to carry out various cultural activities related to laboratory safety , such as organizing knowledge competitions, safety lectures, accident response simulation exercises, and other activities every year in conjunction with National Security Day. The second is to invite outstanding managers in laboratory management to conduct discussions on laboratory regulations. For example, Tsinghua University regularly holds laboratory safety sharing sessions, inviting renowned laboratory managers from Chinese and foreign universities to participate in discussions and share their experiences in laboratory safety management. The third is to go out and bring in. It is a must to regularly dispatch laboratory management personnel to sister universities to conduct research and learn about excellent laboratory safety management paradigms, introduce advanced laboratory safety management methods, and enhance laboratory safety culture construction.

In terms of management, it is necessary to fully operate digital and information technology methods, and increase the promotion of laboratory safety culture. The first is to build a digital platform for laboratory safety culture, displaying laboratory regulations, emergency plans, maintenance and safe use of laboratory facilities, and various safety culture activities in a column format on the digital platform. Regular digital platform courses related to laboratory safety will be held to encourage teachers and students to learn, thereby increasing the promotion of laboratory safety culture. The second is to deepen the application of digital technology, such as establishing a laboratory shared database, storing, filtering, and processing massive laboratory data through a dedicated cloud platform, refining

and preserving valuable safety information, including typical examples of dangerous accidents and level information of various experimental environment safety levels, providing users with rich safety culture learning and training materials, and enhancing laboratory safety culture promotion.[7] The third is to simulate the laboratory safety risk environment through artificial intelligence and digital simulation technology. Teachers and students are invited to participate in emergency simulation activities in the laboratory, strengthen the laboratory safety culture, and increase the promotion of laboratory safety culture.

5. CONCLUSION

The safety of university laboratories is an important component of campus safety, which has a certain impact on social and national security. Building a safety culture in university laboratories is of great significance for the overall safety of university laboratories. Faced with the problems of insufficient theoretical foundation of laboratory safety culture in colleges and universities, formalized education and training, single cultural activities, and shallow cultural propaganda, drawing on the experience of laboratory safety culture construction in domestic and foreign universities, it is proposed to build a laboratory safety culture in the dimensions of ideology, individuals, collectives, and management. This has certain practical value for promoting laboratory culture construction and ensuring laboratory safety. In the later stage, it is necessary to further promote relevant research in the connotation and key areas of laboratory culture construction.

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