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Exploration on the Practice Paths for Building Safety Culture in University Laboratories

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Abstract: ***With the country's increasing emphasis on safety in higher education institutions, the construction of laboratory safety culture has been included as a mandatory inspection item for laboratory safety in universities. To ensure the normal conduct of experimental teaching and research activities and the personal safety of faculty and students, proposes safety management concepts that integrate '5S' (detailed explanation in section 2.1) with classification and grading, emphasize seamless and full-life cycle management, prioritize safety and preventive measures, emphasize service with a combination of rewards and punishments, keep pace with the times, and involve all staff. It actively explores practical paths for implementing laboratory safety culture construction, providing a reference for the construction of laboratory safety culture in higher education institutions.***

Keywords: University laboratories; Safety culture; Digital management; Closed-loop awareness; Life-cycle Management.

1. INTRODUCTION

University laboratories serve as vital bases for experimental teaching and scientific research, undertaking the important tasks of cultivating students' innovative consciousness and enhancing their practical abilities. In recent years, with the country's increasing emphasis on safety in higher education institutions, many domestic universities have invested significant human, material, and financial resources in laboratory construction and management. The hardware and software of laboratories have been greatly improved. However, there is a notable deficiency in the construction of laboratory safety culture. According to incomplete statistics, more than 90% of laboratory accidents in universities are caused by human factors, ultimately due to the absence of a laboratory safety culture or the inability of faculty and students to fully understand and accept laboratory safety culture (Ma et al., 2024).

Laboratory safety culture is gradually formed through long-term standardized operation of laboratories. To establish and cultivate a good laboratory safety culture atmosphere, it is essential to focus on the cultivation of safety awareness and safety abilities, enabling faculty and students to possess extensive safety knowledge and professional skills, instinctively reverence life, consciously abide by safety regulations, ensure the safety and stability of laboratories, and jointly build a safe campus. Additionally, students with good safety qualities will undoubtedly influence those around them after entering society, gradually contributing to a virtuous cycle of social laboratory safety culture ecology. This is beneficial both in the current era and for future generations.

Therefore, based on work experience, the key to exploration on individual people, focusing on the implementation of the university laboratory safety culture construction practice path. By leveraging the guiding role of laboratory safety culture to provide a better and safer laboratory environment for faculty and students.

2. ISSUES IN THE CONSTRUCTION OF LABORATORY SAFETY CULTURE

Since strengthening safety culture construction was included in the safety inspection list for university laboratories, many domestic universities have actively explored laboratory culture construction and achieved certain results. However, there are still numerous problems.

2.1 Insufficient Attention at the Top Level

Safety awareness determines safety behavior and is the foundation for safety management and risk control. The most important aspect of constructing a laboratory safety culture is for the top-level administration of the school to establish safety awareness, possess correct and reasonable safety concepts, and put them into action. However, the construction of safety culture has issues such as a long cycle and slow returns, making it easy to be overlooked by

leaders at all levels. Over time, many university teachers and students have weak safety awareness, leading to a lack of safety culture (Zhou & Ji, 2023).

2.2 Insufficient Professional Skills of Management Personnel

The professional skills of laboratory safety management personnel directly affect the construction of laboratory safety culture. Due to various reasons, some university leaders only pay lip service to the construction of laboratory safety management teams, delaying the implementation. This results in insufficient staffing of dedicated personnel, a lack of professional skills, and difficulties in forming a good laboratory safety culture.

2.3 Low Participation of Teachers and Students

The construction of laboratory safety culture often adopts a top-down approach, based on school safety management requirements such as training duration for teachers and students and the frequency of laboratory inspections. Teachers and students are in a passive state rather than acting autonomously and voluntarily, greatly weakening the influence of safety culture construction.

2.4 Ineffective Safety Training

Over 90% of laboratory safety accidents are caused by operators' weak safety awareness or irregular operations. Many universities have few safety training sessions, or they are merely a formality. Especially at the college and laboratory levels, teachers and students focus more on teaching and research achievements, neglecting the importance of laboratory training, leading to ineffective training.

2.5 Limited Information Management Means

In recent years, information technologies such as ‘Internet+’ and big data have accelerated the pace of safety culture construction, and universities have increasingly valued information management means for laboratories. However, due to limited safety funds for laboratories, investments can only be made in batches or phases. Additionally, information technology updates rapidly, resulting in a short duration of effectiveness for laboratory information management, which is not conducive to the construction of laboratory safety culture.

3. THE MANAGEMENT CONCEPTS THAT SHOULD BE ESTABLISHED FOR LABORATORY SAFETY CULTURE CONSTRUCTION

Laboratory safety culture construction has become a mandatory inspection item for laboratory safety in higher education institutions. To build a laboratory safety culture with the institution's own characteristics, universities should establish the following concepts in their laboratory safety management practices.

3.1 The Concept of Combining 5S with Classification and Grading in Safety Management

‘5S’ stands for Sort, Set in Order, Shine, Standardize and Sustain, which involves effective management of laboratory personnel, equipment and facilities, experimental materials, experimental methods, and experimental environments. It advocates starting small and cultivating good experimental habits in everything.

Classification and grading of laboratory safety are based on the characteristics of hazards and their severity for safety risk assessment, accompanied by specialized safety management and preventive measures. Classification and grading of laboratory safety involve categorizing and grading potential risks arising from reagents and consumables, instruments and equipment, operational processes, and waste generated during storage or experimentation in laboratories. By implementing the primary responsibility for laboratory safety, the scientific, effective, and targeted nature of management is enhanced.

In the process of constructing laboratory safety culture, emphasis should be placed on leveraging the synergistic effects of 5S and classification and grading management to enhance the safety awareness and safety literacy of teachers and students, fostering an instinctive reverence for life and spontaneous compliance with laboratory safety rules and regulations.

3.2 The Concept of Seamless and Full Life-cycle Management

Seamless management originates from an advanced management method in Western countries, emphasizing the absence of gaps in all aspects of management to achieve comprehensive control (Wang & Wu, 2013). Full life-cycle management refers to the dynamic management of the entire life-cycle of the management object. In recent years, the overall situation of laboratory safety management in universities has gradually improved, but there are still blind spots in safety management and supervision (Jiang & Wen, 2021; Zhang et al., 2022). The concepts of seamless and full life-cycle management will effectively fill in management gaps and deficiencies, achieving dynamic and comprehensive supervision without blind spots.

3.3 The Concept of Safety First and Pre-emptive Prevention

Laboratory safety culture construction should adhere to and implement the concept of safety first and pre-emptive prevention. Risks and hazards in laboratories must be classified and graded, with control measures taken and responsibilities assigned to individuals. Regular dynamic assessments should be conducted to prevent potential hazards in advance, ensuring that "safety first, prevention foremost" is not just a slogan.

3.4 The Concept of Service Orientation Combined with Rewards and Punishments

Laboratory safety culture construction should adhere to the concept of service orientation combined with rewards and punishments. Service orientation means shifting from safety management to safety service, ensuring that service to teachers and students is never lacking. Leaders should lead by example, visit laboratories, and address urgent safety issues faced by teachers and students. Meanwhile, to ensure orderly progress in laboratory safety culture construction, feasible reward and punishment measures must be formulated to fully mobilize the enthusiasm and initiative of teachers and students, thereby enhancing the level of laboratory safety management.

3.5 The Concept of Keeping Abreast of the Times and Full Participation

Today's society is undergoing significant development and transformation, with the Internet technology accelerating its pace. Laboratory safety culture must adhere to the concept of keeping abreast of the times and full participation. Keeping abreast of the times means not absolutizing experience but continuously learning new knowledge, broadening horizons, and keeping pace with the times and reforms. Full participation means not relying solely on leadership but involving all employees, relying on them, and stimulating their intelligence and wisdom, ultimately benefiting the school and satisfying employees.

4. PRACTICES FOR BUILDING A LABORATORY SAFETY CULTURE

The development of a laboratory safety culture is a lengthy process that necessitates the emphasis and support of leaders at all levels within universities, as well as the continuous exploration and dedication of all faculty and students, in order to foster a safe and orderly laboratory environment.

4.1 Emphasis from Leaders and Establishment of a Comprehensive Safety Responsibility System

The development of a laboratory safety culture is a systematic project that cannot be accomplished overnight. Firstly, it requires enhancing leaders' safety awareness so that they prioritize safety work, thereby fulfilling their own responsibilities. This includes establishing a well-defined organizational structure and safety responsibility system, clarifying the job duties and authorities of personnel at all levels, organizing the signing of safety responsibility agreements, and ensuring that safety responsibilities are implemented at every level, as illustrated in Figure 1, to seamlessly integrate safety work into practice.

Secondly, leaders at all levels must not only fully recognize the importance and necessity of developing a laboratory safety culture, incorporating all laboratory work into a framework that prioritizes safety and prevention. More importantly, they should establish special safety funds at various levels to provide support for the effective implementation of laboratory safety culture development.

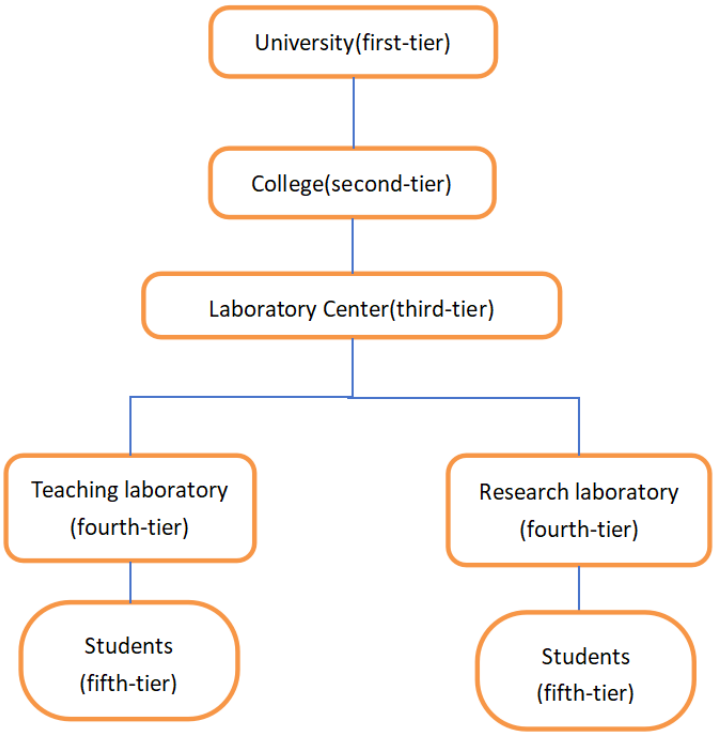

Figure 1: Responsibility System for Laboratory Safety Management

4.2 Strengthening Education and Establishing a Safety Learning System

In the specific implementation of laboratory safety culture construction, it is essential to prioritize safety education to enhance the safety awareness and skills of both teachers and students. Through a three-tier access safety education system for laboratories, as illustrated in Figure 2, every teacher and student will gain knowledge of general safety, specialized professional knowledge, and experimental operational skills, thereby fostering a strong safety consciousness and practical firefighting capabilities.

Given the varying levels of competence within the laboratory safety management teams and the presence of complacency, measures such as competitive job placement and linking annual performance evaluations can be employed. These methods encourage laboratory safety management personnel to deepen their professional knowledge, strengthen their sense of responsibility for safety management, and improve their safety management capabilities. By utilizing diverse online and offline training and educational programs, the theoretical understanding and experimental operational abilities of safety management personnel can be substantially enhanced, ensuring the effective advancement of laboratory safety culture construction.

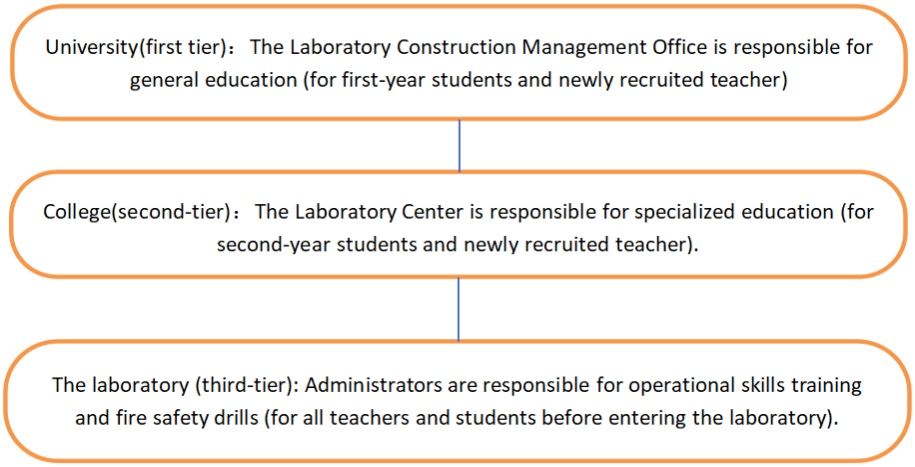

Figure 2: Three-Tier Safety Access Education for Laboratories

4.3 Leveraging Platforms for Digital Supervision and Evaluation

The supervision and evaluation of laboratory safety culture construction primarily rely on the digital management platform for laboratory safety. This platform includes the organizational structure of school safety management, laboratory classification and categorization, safety inspection modules, access education modules, rules and regulations, emergency plans, and drills. The platform's operation effectively meets the basic requirements for hierarchical and categorized management of laboratory safety at the school level, enabling integrated and coordinated management of laboratories and promoting the efficient sharing of laboratory resources.

To more effectively conduct supervision and evaluation of safety culture construction, the platform grants sufficient permissions to safety management personnel at all levels, reducing communication and decision-making time costs. This encourages school and college-level units to actively engage in safety culture construction. Daily laboratory safety tasks are recorded on the platform to facilitate dynamic supervision and regular evaluation at both school and college levels.

4.4 Full Participation: Launching the "Snap and Share" Campaign

To better promote laboratory safety culture construction, the school should establish an effective safety information communication system. The "Snap and Share" initiative involves using mobile phones to capture images of potential safety hazards or safety compliance in laboratories, which are then uploaded to safety work groups or safety management apps via the internet. Practice has shown that "Snap and Share" is an effective medium for disseminating and communicating safety information.

By encouraging teachers and students to participate in "Snap and Share," they are transformed from passive observers to active supervisors in laboratory safety management. This initiative engages them in the construction of laboratory safety culture, guiding them to prioritize and advocate for safety, thereby enhancing the safety awareness of the entire community and fostering safe habits.

The construction of laboratory safety culture follows the concept of closed-loop management. Dedicated personnel are responsible for standardizing laboratory operations, ensuring that "Snap and Share" initiatives are tracked and effectively implemented. Upon identifying safety hazards, designated personnel are responsible for timely feedback, investigation, rectification, and regular evaluation and reporting. This approach truly achieves closed-loop management of laboratory safety, as illustrated in Figure 3.

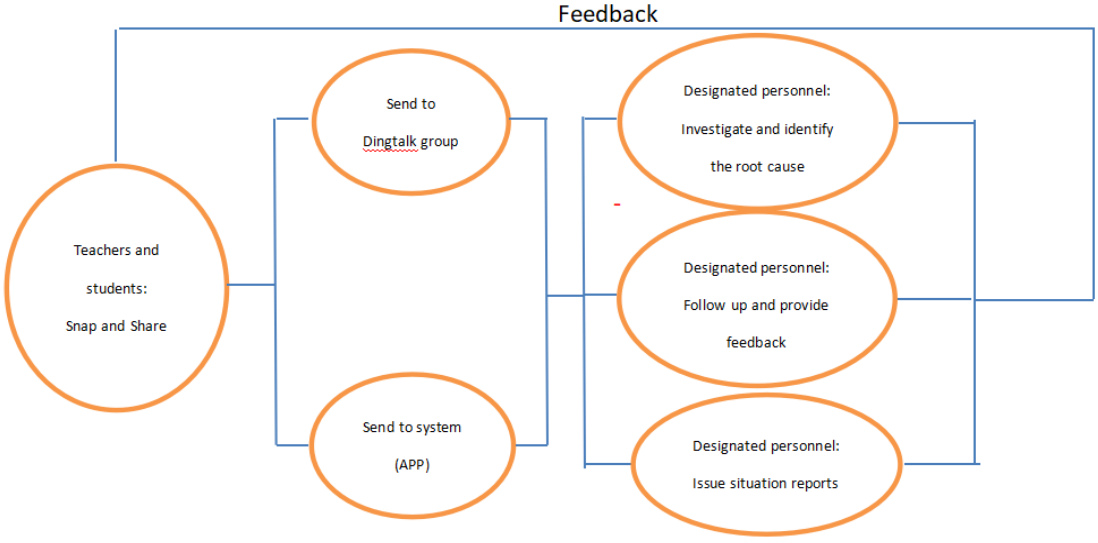

Figure 3: Closed-loop Management of Safety Hazards.

4.5 People-Oriented: Establishing a Positive Incentive Mechanism

To achieve standardized safety management and normalized safety behaviors, it requires the active participation and proactive efforts of all individuals, the cultivation of a safety culture, and the establishment of a positive incentive mechanism. Without these, safety management would be like "a tree without roots or a meal without

rice."

The positive incentive mechanism adheres to a people-oriented approach. Material rewards, as the primary need of individuals, are unavoidable and must be promptly granted to individuals. At the same time, platforms should frequently be provided for teachers and students to showcase personal and team honors, allowing them to share their work experiences, achievements, and insights, and to feel the recognition from leaders and encouragement from colleagues. More importantly, personal growth is a significant form of positive incentive. Schools should implement clear policy preferences for the promotion and professional title evaluation of safety management personnel, fully unleashing their potential and greatly motivating their initiative. This encourages them to think, act, and innovate more, thereby forming a virtuous cycle and promoting the sustained and healthy development of safety culture construction.

5. CONCLUSION

The safe operation of university laboratories is inseparable from the development of a safety culture. The construction of a laboratory safety culture is a major project that hinges on individuals and requires long-term and unremitting efforts. It necessitates overall planning by the university, supervision and implementation by functional departments, and active engagement by secondary colleges and individual laboratories in safety activities tailored to their respective disciplines and majors. These efforts aim to elevate the ideological and spiritual qualities of teachers and students, gradually fostering self-management among them, shifting from passive compliance to active participation, and cultivating a good habit of transitioning from "I am required to be safe" to "I want to be safe" (Zhang et al., 2022).

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