

A study on the current situation of chemistry laboratory construction and management in undergraduate colleges and universities

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Abstract

With the development of higher education, the laboratory construction in undergraduate colleges and universities has become increasingly important, serving as a crucial indicator of their teaching and research capabilities. However, some chemistry laboratories face issues such as low resource utilization efficiency, long construction cycles, and limited functionality. This paper deeply analyzes the current situation of undergraduate chemistry laboratories in terms of system construction, platform development, and talent cultivation, and proposes strategies such as optimizing laboratory platforms and facilities, strengthening the professional capabilities of teaching and management teams, and innovating management models. The aim is to provide a reference for the laboratory construction of undergraduate colleges and universities, promote the efficient integration of educational resources, further enhance teaching quality and research innovation capabilities, and drive the high-quality development of higher education.



Full Text Article



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Keywords: undergraduate colleges and universities; chemistry laboratories; improvement pathways

Introduction

In recent years, with the country's emphasis on higher education, undergraduate colleges and universities have experienced rapid development, with an expanding enrollment scale. Despite the emergence of new majors, the laboratories of the historic chemistry and chemical

engineering majors in these institutions remain crucial venues for experimental teaching, scientific research, and talent cultivation in the fields of chemistry and chemical engineering. These laboratories have surpassed the traditional concept, undergoing reorganization or new construction to meet evolving needs^[1]. As higher education continues to evolve and experimental teaching reforms deepen, the construction and management of chemistry laboratories in undergraduate colleges and universities face numerous challenges. Under limited resources, these institutions are confronted with new demands to build modern chemistry laboratories with high standards and efficiency. A powerful chemistry laboratory not only requires foresight and scientific rigor but must also align with the needs of discipline development^[2]. Additionally, it should possess excellent software conditions, superb management capabilities, and a high-quality, highly skilled experimental team.

Problems in the management of chemistry laboratory construction in public undergraduate schools

2.1 Serious compartmentalisation of resources and poor top-level design

Due to the differences among disciplines, professions and courses, the division of laboratory resources is inevitable^[3]. However, excessive division not only makes it impossible to share and optimise laboratory resources, but also leads to duplication and wastage of laboratory resources. In addition, due to the lack of unified planning and design, there is also the problem of uneven distribution of resources in the vertical dimension of laboratories. Some popular disciplines have relatively adequate laboratory resources, while some cold disciplines are under-resourced. This uneven distribution of resources has to a certain extent hindered the development of the disciplines and the quality of talent training.

2.2 Inadequate laboratory management system

A sound laboratory management system is crucial for ensuring the normal operation of laboratories. However, currently, many vocational colleges' chemistry laboratories face issues with their management systems. Firstly, the safety management system in laboratories is not perfect. Some laboratories lack necessary safety facilities and warning signs, posing potential safety hazards. Secondly, the equipment management system in laboratories is not stringent enough. Some equipment lacks standardized management processes in terms of use, maintenance, and repair, leading to damage and waste. Additionally, the personnel management system in laboratories is not clear enough^[4-5]. Some laboratories lack clear regulations on the responsibilities, rights, and obligations of laboratory personnel, resulting in varying levels of responsibility awareness and management skills among them.

2.3 Software and hardware conditions of laboratories need to be upgraded

The construction and management of chemistry laboratories rely on solid software and hardware support. However, at present, many undergraduate universities' chemistry laboratories still face numerous challenges in this regard. On the one hand, some laboratories lack cutting-edge experimental instruments and equipment, which undoubtedly undermines

the quality and effectiveness of experimental teaching^[6-7]. On the other hand, the spatial planning of some laboratories is not entirely reasonable, and the basic supporting facilities such as ventilation and lighting need to be improved, causing inconvenience in experimental operations^[8]. Furthermore, issues such as equipment aging and delayed updates also exist in some laboratories, which similarly have an adverse impact on the quality and effectiveness of experimental teaching^[9].

2.4 Inadequate quality of the experimental technical team

Laboratory technicians are the key force in laboratory construction and management. However, at present, some undergraduate chemistry laboratories still face several challenges in the construction of experimental technology teams. Firstly, the professional quality of experimental technicians needs to be improved urgently. Some laboratory technicians lack the necessary professional knowledge and skills, resulting in deficiencies in experimental operation and management. Secondly, there is an insufficient number of experimental technicians. Some laboratories have been affected by insufficient staffing, which has affected their daily operations and management. In addition, the management level of experimental technicians also needs to be improved. Some personnel lack necessary management experience and methods in personnel scheduling, equipment management, and other aspects, which affects the laboratory's operational efficiency and management level^[10].

Pathways and Countermeasures of Chemistry Laboratory Construction Management in Undergraduate Colleges and Universities

3.1 Precise top-level design and planning

The construction planning of chemical laboratories in undergraduate colleges is the core of laboratory management in vocational colleges, involving the improvement of laboratory facilities, the updating of equipment, and the optimization of space. This plan aims to ensure the smooth progress of experimental teaching and scientific research activities by improving the hardware conditions and environment of the laboratory, while also enhancing the safety, efficiency, and sustainability of the laboratory^[11-12]. Specifically, the improvement of laboratory facilities requires laboratories to have premises, facilities, and environments that meet the requirements of experimental technology work; The renewal of laboratory equipment focuses on introducing high-end, intelligent, and green instruments and equipment to enhance scientific research capabilities and teaching standards; The optimization of laboratory space focuses on safety, flexibility, and adequate storage space to enhance efficiency and safety, ensuring the efficient operation and sustainable development of laboratories^[13].

The accuracy of the top-level design and planning of a chemistry laboratory is crucial to its functionality and safety. Chemistry laboratories are places for chemistry teaching and scientific research. The design of the laboratories should take into full consideration the needs of various experimental operations and ensure that the laboratories can provide a safe, comfortable and efficient working environment. It is only through accurate top-level design that the various functional areas can be laid out in a reasonable manner, the smooth flow of

experimental operations can be ensured, and the necessary safety facilities and emergency measures can be provided to prevent and cope with accidents in the course of experiments.

Top-level design planning for chemistry laboratories is crucial for the configuration and layout of experimental equipment and instruments. It needs to ensure that equipment selection and layout match the functional needs of the laboratory and optimise the co-ordinated use of equipment as well as the flow of sample and reagent transfer. Accurate top-level design can rationally arrange experimental benches and equipment areas, reduce interference and cross-contamination between instruments, and improve work efficiency and data accuracy. At the same time, the design also needs to consider safety, efficiency, special equipment layout, environmental control, water supply and drainage and electrical requirements, as well as telecommunication and information management systems to ensure the efficient operation of the laboratory and to meet the accuracy and safety requirements of the experiments.

Precise planning of the top-level design of a chemistry laboratory can also leave enough space and room for future development of the laboratory. The top-level design of the laboratory should take into full consideration the possible future direction of scientific research and teaching needs, and provide flexible and changeable experimental areas and equipment, so as to facilitate the upgrading and modification of the laboratory at any time. Only through accurate top-level design can it be ensured that the laboratory can adapt to the needs of scientific and technological development and teaching reform.

The top-level design of chemistry laboratories in undergraduate institutions needs to be precise in order to ensure the functionality and safety of the laboratories, the rational allocation of instruments and equipment, the effective management of air quality and environmental control, as well as the provision of sufficient space for future development. Such a design ensures that the laboratory provides a safe, efficient and comfortable working environment for the smooth running of teaching and research^[14].

3.2 Well-established institution-building

A well-established system for chemistry laboratories in undergraduate institutions can ensure that the requirements for laboratory safety, resource management, experimental teaching, scientific research support and environmental protection are effectively met. This is not only a requirement for laboratory management, but also the basis for ensuring the smooth conduct of laboratory work and the health and safety of personnel.

A chemical laboratory is a high-risk working environment involving many dangerous chemicals, high-temperature and high-pressure equipment and explosive substances. A well-established system can ensure the formulation and implementation of safe laboratory practices to minimise the risks to laboratory personnel and the surrounding environment.

Resources such as instruments, equipment, reagents and materials in the laboratory need to be effectively managed and maintained to ensure their normal operation and service life. The establishment of a sound system for the loan of instruments and equipment, reagent use and inventory management will enhance the efficiency of resource utilisation and save costs.

Chemistry laboratories in undergraduate colleges and universities are important places for cultivating students' practical skills and mastering professional knowledge. A sound system

can regulate the process of experimental teaching, clarify the contents and requirements of experiments, and provide a standard experimental procedure and evaluation system to ensure the quality of experimental teaching. Researchers also need to have strict rules and procedures for conducting scientific experiments and data collection^[15]. A well-established system can provide support for the declaration of scientific research projects, the use of funds, and the management of experimental data, thus facilitating the production of scientific research results and academic exchanges.

In addition, chemical laboratories usually produce waste and pollutants, which have an impact on the surrounding environment. The establishment of a reasonable waste disposal and environmental monitoring mechanism can ensure the environmental safety and sustainable development of the laboratory.

3.3 Excellent hardware and software conditions

Excellent hardware and software conditions in chemistry laboratories of tertiary institutions are necessary to ensure experimental safety, enhance experimental precision and support experimental teaching and scientific research. Only with advanced facilities and equipment can a safe, efficient and innovative experimental environment be created for teachers and students and excellent chemistry professionals be trained.

Chemical experiments involve a series of dangerous chemicals and operations, so laboratories must have good hardware and software facilities to ensure the safety of the experimental process. For example, the laboratory must be equipped with fire-fighting equipment, safe ventilation systems and safety cabinets to cope with the risk of accidents or chemical leakage and to protect the personal safety of teachers and students^[16].

In chemistry experiments, accurate data and results are very important. The laboratory must be equipped with advanced instruments and equipment, such as high-precision balances, spectrophotometers, gas chromatographs, etc., to ensure the accuracy and reliability of the experimental data. Similarly, the laboratory needs to provide stable environmental conditions, such as constant temperature and humidity, pure water and gas supply, to ensure consistency and control of the experimental conditions.

Chemistry laboratories in undergraduate institutions are not only used for scientific research, but also play an important role in developing students' practical skills and scientific spirit. Therefore, the laboratory needs to provide sufficient space and equipment to meet the teaching needs. For example, to enable students to carry out independent experimental operations and observations, the laboratory should be equipped with a sufficient number and variety of experimental benches, reagent racks, microscopes, etc. In addition, the laboratory should be equipped with an adequate number of laboratory tables, reagent racks, microscopes, etc. to enable students to carry out independent experimental operations and observations^[17]. In addition, advanced multi-media equipment and real-time monitoring systems should be provided to support the display and safety management of experimental teaching.

Apart from teaching, chemical laboratories in undergraduate institutions are also tasked with the mission of scientific research. In order to support scientific research, the laboratory must be equipped with advanced research equipment and technology platforms. For example,

the laboratory needs to be equipped with advanced chromatographs, mass spectrometers and nuclear magnetic resonance (NMR) instruments to meet the needs of different research directions. At the same time, the laboratory needs to provide high-speed network, data storage and processing equipment to support the collection, analysis and archiving of research data.

3.4 Highly qualified experimental and technical team

The laboratory technology team of chemistry laboratories in undergraduate colleges should be of high quality, which is not only related to the quality of laboratory teaching, but also involves the cultivation of scientific research ability and practical ability of students. High-quality laboratory technology team is an important guarantee to achieve the goal of cultivating applied talents in higher vocational colleges and universities.

High-quality laboratory technology team can guarantee the safety of laboratory teaching. In chemical experiments, a series of toxic, flammable, explosive and other dangerous substances are often involved, and a rigorous experimental technology team can operate correctly, standardise the operation procedures and ensure the safety of the experimental process. High-quality laboratory technicians have in-depth understanding of the operation principles of laboratory equipments, safety operation procedures, etc., and are able to deal with emergencies in time, prevent chemical leakage, fire and other dangerous incidents, and effectively maintain laboratory safety^[18].

High-quality laboratory technology team plays a key role in the detailed management of laboratory teaching and the promotion of scientific research. Laboratory technicians should have the ability to make strict experimental plans and design experimental programmes, and provide scientific and reasonable technical support for teaching and scientific research^[19-20]. They should master advanced experimental methods and techniques, and be able to complete complex experimental operations independently to improve the accuracy and reliability of experimental data. At the same time, high quality laboratory technicians can actively participate in scientific research projects, promote scientific research in the laboratory, and strive for more scientific research projects and funds for the university.

High-quality laboratory technicians are crucial to the cultivation of students' practical ability. Laboratory technicians are not only instructors in laboratory teaching, but also role models for students' practical operation. Skilled experimental operation skills, solid theoretical foundation and serious and responsible working attitude will have a positive influence on students. Through interaction with laboratory technicians, students can better understand the course knowledge, grasp the experimental operation skills and develop practical hands-on abilities. High-quality laboratory technicians can provide personalised guidance to students according to their actual level, so that students can get a more comprehensive and systematic cultivation of academic literacy in the laboratory.

High-quality laboratory technicians can help to build innovative laboratories. Laboratory technicians should not only master the traditional experimental techniques, but also keep pace with the development of science and technology, and introduce advanced instruments and experimental methods. They should be innovative and actively participate in the technological renovation and updating of the laboratories to promote the modernisation of the laboratories.

Such a laboratory environment will help to attract high-level scientific research talents and improve the university's scientific research level and competitiveness.

Conclusion

The construction of chemical laboratories in undergraduate colleges is a long-term, arduous and complex systematic project. In order to improve the quality of education and scientific research, higher vocational colleges and universities must devote themselves to the construction of laboratories and make them an important place for cultivating students' practical ability and innovative spirit. Increasing capital investment is the key to laboratory construction. Higher vocational colleges and universities need to invest a lot of money in the construction of the environment and facilities of chemistry laboratories to ensure that the laboratories are equipped with advanced and complete laboratory equipment and devices to meet the needs of various scientific research and teaching. At the same time, undergraduate institutions also need to pay attention to the construction of environmental protection and safety facilities in laboratories to ensure that teachers and students can carry out experimental activities in a safe and comfortable environment.

At the same time, the cultivation of a high-quality, high-level, structurally rational, technically proficient, innovative and creative team of laboratory technicians is the most important task in the construction of laboratories. Undergraduate colleges and universities need to pay attention to the training of laboratory technicians to improve their professional quality and technical level. Through training and academic exchanges, they should encourage laboratory technicians to learn new knowledge and master new skills in order to adapt to the ever-changing needs of scientific research and teaching.

Universities also need to strengthen the scientific research management of laboratories to enhance the organisation and management of experimental work. They need to ensure that research work in laboratories is carried out in an orderly manner by formulating reasonable research plans and project management systems. At the same time, higher vocational colleges also need to pay attention to the opening up of their laboratories to the outside world, strengthen the co-operation with enterprises and scientific research institutions, and promote the transformation and application of scientific and technological achievements. Only in this way can the laboratories become a base for teaching and experimentation, scientific research and innovation in undergraduate colleges, improve students' practical ability and innovation spirit, and make important contributions to the cultivation of high-quality talents.

Acknowledgement

This paper was finally supported by Huzhou College scientific research project (2024HXKM04).

Conflict of Interest

The authors declare no conflict of interest.

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