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The Current Situation and Countermeasures of University Chemistry Laboratories in the Context of the Information Age

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Abstract: Against the background of rapid iteration of information technology and high-quality development of higher education, university chemistry laboratories, as core bases for chemistry teaching, scientific research innovation and talent cultivation, play a key role in professional talent training quality with their information-based management level and efficiency. Based on this background, this paper briefly analyzes the importance and current situation of chemistry laboratory management in universities under the information age, and discusses optimized countermeasures for university chemistry laboratory management, aiming to provide theoretical references for promoting the high-quality development of university chemistry laboratories in the information era.

Keywords: Information age; University chemistry laboratory; Optimization countermeasures

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1. Introduction

With the rapid development of information technologies such as big data, artificial intelligence and the Internet of Things, higher education has also ushered in new opportunities and challenges for digital transformation. University chemistry laboratories are important places for practical teaching, scientific research innovation and talent cultivation in chemistry disciplines, undertaking the task of cultivating students' experimental operation ability, innovative thinking ability and scientific inquiry spirit. At present, the development of chemistry education in universities tends to be interdisciplinary, precise and intelligent, which puts forward higher requirements for the equipment conditions, management methods and service capabilities of chemistry laboratories. Therefore, exploring the current situation of university chemistry laboratories in the information age and putting forward effective optimization countermeasures are of great practical significance for promoting the transformation and upgrading of university chemistry laboratories, improving the school-running level of chemistry disciplines and cultivating innovative chemistry talents meeting the requirements of the new era.

2. Importance of university chemistry laboratory management in the information age

2.1. Building a solid laboratory safety line

University chemistry laboratories are not only equipped with precision instruments and various chemical reagents, but also places for teachers and students to carry out experiments. Safety is an important prerequisite for the management of university chemistry laboratories. In the information age, the management of university chemistry laboratories should also keep pace with the times by introducing information technologies such as the Internet of Things and intelligent sensors to build an intelligent and traceable safety management system, so as to realize the whole-process digital tracking of the procurement, storage, use and disposal of chemical instruments and reagents, and conduct real-time monitoring of parameters such as temperature, humidity and chemical gas concentration in the laboratory [1]. Once abnormal values are monitored, the system will automatically trigger an early warning mechanism and notify laboratory managers, relevant teachers, and students at the first time through sound and light alarms, online system push, and other methods, so as to quickly take emergency disposal measures and effectively avoid potential safety hazards.

2.2. Optimizing teaching and research efficiency

Chemistry is a highly practical discipline, and experiments are the core carrier of practical education. The construction of an information-based chemistry laboratory management platform in universities can efficiently integrate and share chemistry experiment teaching resources. With the help of virtual laboratories, teachers can provide students with immersive and repeatable experimental opportunities, which can not only make up for the shortage of physical experimental resources, but also allow students to experience some high-risk or precision experiments that cannot be carried out in reality, further expanding the breadth and depth of chemistry experiment teaching [2]. In addition, teachers use big data technology to analyze experimental data and the use of experimental instruments statistically, and the data reports obtained are important bases for optimizing teaching modes and promoting scientific research projects, so as to promote the simultaneous improvement of students' practical ability and teachers' scientific research literacy, which also meets the requirements of digital and intelligent development of higher education in the new era.

2.3. Promoting the green development of laboratories

The application of information technology in university chemistry laboratories helps to promote their own green development. For example, the construction of a digital reagent management platform can accurately count the demand for various chemical reagents and then purchase them on demand. This can not only reduce reagent waste and backlog from the source, but also avoid environmental pollution caused by reagent deterioration due to long-term storage. In addition, with the help of VR and AR technologies, students can carry out experimental operations that consume a large amount of chemical reagents and produce wastes in virtual scenarios, which can effectively reduce the resource cost and environmental pollution of actual experiments [3]. At the same time, university chemistry laboratories can also use information technology to establish a green experiment evaluation system, quantitatively evaluate the environmental protection and resource utilization rate of current experimental contents and quantities, guide teachers and students to establish a sense of green development, and promote the green and sustainable development of chemistry laboratory management.

3. Current situation of university chemistry laboratories in the information age

3.1. The management mechanism needs to be optimized

At present, some university chemistry laboratories still adopt traditional management modes and face many challenges in information construction. On the one hand, the laboratory management system is relatively scattered, and the staffing, instrument use, reagent management, security and other work are in the charge of different departments or faculty members, with poor information interaction between various links, and the "information island" phenomenon occurs from time to time. For example, it is difficult to share the registration of experimental instrument collection, maintenance records and reagent collection in real time, making it impossible for managers to grasp the overall operation of the laboratory in a timely and comprehensive manner, thereby affecting management efficiency [4]. On the other hand, the information application of the laboratory management system in some universities is relatively limited. Although some universities have introduced information management systems, the relevant management systems and processes have not been adjusted accordingly in a timely manner, and paper applications and manual records are still used sometimes, failing to give full play to the role of the information system.

3.2. Insufficient resource allocation efficiency

In terms of instruments and equipment, university chemistry laboratories are usually equipped with advanced chemical experimental instruments, but most of their use status, reservation information and maintenance records are paper files and not uploaded to the information platform. For example, although some precision experimental instruments are idle, the previous user did not register and return the information in a timely manner, and teachers and students still have to "wait in line" to use them, resulting in a waste of experimental resources [5]. At the same time, the current maintenance of experimental instruments mainly relies on manual inspection and empirical judgment, making it difficult to carry out preventive maintenance and avoid the impact of sudden instrument failures on the orderly development of teaching or scientific research. In terms of chemical reagents, due to the uneven level of laboratory management informatization, teachers and students need to spend a lot of time looking for key information such as reagent storage location, purity level and safety data sheet when receiving chemical reagents, resulting in low experimental preparation efficiency and increased safety risks.

3.3. Safety education needs to be strengthened

Most university chemistry experiment safety education is mainly based on teachers' oral explanation and warning video watching, and the education forms mostly stay at the theoretical level, making it difficult for students to truly realize the importance of experimental safety and internalize and externalize safety precautions. At the same time, the establishment and improvement of chemistry laboratory safety education mechanisms in some schools are often carried out after safety accidents, making safety education formal and lacking systematicness [6]. In addition, some universities have begun to introduce digital means such as VR and AR technologies to carry out experimental safety education and training. However, due to the constraints of funding investment, technical support and faculty strength, digital experimental safety education means have not been fully applied and promoted, failing to provide students with an immersive and experiential training process. For example, students cannot use VR technology to simulate the emergency escape and disposal processes of sudden events such as toxic gas leakage and accidental experimental fire, making it difficult to improve their safety awareness and emergency skills effectively.

4. Optimization countermeasures for university chemistry laboratory management in the information age

4.1. Optimize laboratory management mechanism and improve refined management level

Firstly, universities should improve the information system of chemistry laboratory management, build a fully functional and easy-to-operate information system for laboratory management, and carry out all-around information management on experimental equipment, chemical reagents, management personnel, environmental safety, and other aspects. The system should have functions such as equipment management, reagent management, experiment reservation, safety management and data statistical analysis, promote the rapid exchange and sharing of data between different management links, and provide strong data support for chemistry laboratory management decision-making [7]. Taking the reagent management system module as an example, managers can track the whole process of procurement, warehousing, collection, return and scrapping of chemical reagents with the help of the platform, and implement refined management to avoid reagent waste and safety accidents.

Secondly, promote refined management and optimize resource allocation [8]. University chemistry laboratory managers can promote laboratory refined management through the information management system, implement precise regulation and optimal allocation of various laboratory resources. For example, understand the frequency and utilization rate of laboratory equipment through data analysis, rationally allocate equipment resources and improve the equipment utilization rate; formulate reasonable procurement plans according to reagent consumption and reduce reagent backlog and waste; rationally arrange laboratory use time according to the needs of experimental teaching and scientific research to improve laboratory space utilization. At the same time, establish a management data statistical analysis system, periodically analyze management data, find problems in a timely manner, so as to improve management efficiency and level [9]. Finally, improve the management system and standardize the management process. Establish an information management system for chemistry laboratories, formulate a unified laboratory information management system, clarify the management responsibilities of various departments and positions, standardize the management process, and ensure the implementation of the system.

4.2. Strengthen the integration of experimental resources and improve the resource data sharing mechanism

Led by the education department, establish a regional or national university chemistry experiment resource sharing platform dominated by universities, integrate chemistry experiment teaching resources, scientific research resources, equipment resources, reagent resources and so on from different universities and laboratories, and realize centralized management and sharing of resources [10]. The platform should have functions, such as resource query, reservation, sharing and communication to facilitate teachers and students to quickly obtain and use resources. Integrate virtual simulation experiment resources from various universities, establish a virtual simulation chemistry experiment resource library, strengthen inter-school sharing, and improve resource utilization efficiency. In addition, university chemistry laboratory managers should standardize the management of experimental teaching resources, scientific research resources, and data resources, clarify the processes of resource collection, sorting, storage, and sharing, and ensure the accuracy, integrity, and security of resources. At the same time, update and optimize resources, timely supplement and improve the latest experimental teaching content, scientific research achievements and experimental data to improve resource quality. To ensure the efficient integration and sharing of experimental resources, universities

should also establish and improve an experimental resource sharing incentive mechanism to commend and reward universities, laboratories and individuals who actively participate in resource sharing, and mobilize their enthusiasm for resource sharing [11]. For example, universities that share large-scale precision instruments and equipment can be given priority in the use of shared platforms and the distribution of shared benefits; for teachers who actively participate in the development and upload of virtual chemistry experiment resources, this can be included as teaching achievements in the reference for teacher assessment and professional title evaluation.

4.3. Innovate safety education mode and build a diversified safety education system

Online, establish an information-based safety education platform integrating theoretical teaching, case analysis, and virtual drills, providing students with rich learning resources such as experimental safety courseware, typical case videos, and safety operation process demonstration animations, so that they can freely arrange study time and test learning effects through online tests. At the same time, the platform will automatically track students' learning progress and test scores, which can be used by teachers as one of the necessary conditions for entering the laboratory [12]. Offline, teachers comprehensively use physical laboratories and immersive experience technologies such as VR/AR to regularly carry out safety skills practical training such as fire equipment use and emergency rescue drills, and simulate common sudden scenes in laboratories such as fire, explosion and toxic substance leakage, allowing students to experience the accident process in a virtual environment personally, practice emergency disposal processes and escape skills, and enhance safety awareness and emergency handling ability. In addition, establish a normalized experimental safety education and training mechanism as an important part of the whole-process experimental teaching for students to ensure that teachers and students firmly establish safety awareness and master necessary safety skills [13]. For example, managers can use big data mining technology to analyze historical data such as students' experimental behavior, assessment results and laboratory safety accident data, analyze the problems existing in laboratory safety education, so as to improve the content and methods of safety education teaching in a more targeted manner and improve the effectiveness of safety education.

4.4. Strengthen the construction of the talent team and improve the information literacy of managers

Firstly, improve the manager training system and carry out systematic training. Establish a sound information training system for university chemistry laboratory managers and experimental teachers, and regularly carry out information technology training activities, such as information equipment operation, information management system application, information teaching methods, etc., to improve the information level and ability of faculty and staff. In this process, universities can also rely on enterprises and scientific research institutions to carry out special training projects. Universities invite information technology experts to give lectures, organize laboratory managers and experimental teachers to participate in various activities such as information technology seminars and training courses, and obtain advanced information technology and management experience [14]. Encourage managers and experimental teachers to learn information and knowledge by themselves to improve their own information ability. Secondly, introduce professional talents to strengthen technical support. Universities attract and introduce interdisciplinary talents with solid chemistry professional knowledge and information technology ability by constructing a talent introduction mechanism adapted to the actual school and student conditions, enrich the laboratory management and teaching team,

and provide professional support for laboratory information construction. At the same time, improve the assessment and evaluation mechanism to stimulate the work enthusiasm of managers. Optimize the assessment and evaluation system for laboratory managers and experimental teachers, take information technology ability and information work effectiveness as important contents of assessment and evaluation, commend and reward those with excellent achievements, and mobilize their enthusiasm for learning and applying information technology [15]. For example, faculty and staff who have made remarkable achievements in laboratory information construction shall be given preferential policies such as financial rewards and professional title promotion.

5. Conclusion

In summary, under the background of the information age, the management of university chemistry laboratories has ushered in new development opportunities. In the future, university chemistry laboratories should continue to deepen the integration with information technologies such as big data, artificial intelligence and the Internet of Things, and promote the development of laboratories towards intelligence and smartness. Through the introduction of digital technologies such as artificial intelligence, the Internet of Things, and big data, the intelligent perception, analysis, and adjustment of chemistry laboratory equipment, environment, personnel, data, and other aspects can be realized, and the intelligent level and service quality of university chemistry laboratories can be comprehensively improved.

Disclosure statement

The author declares no conflict of interest.

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