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Construction of a Virtual Simulation Practice Teaching System of the Chemical Industry Under the Background of Integration of Production and Education

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Abstract: With the development of the integration of production and education, chemical engineering and technology education is facing many new challenges and opportunities. The construction of a chemical virtual simulation practice teaching system under the background of integration of production and education aims to improve students' learning efficiency and innovation ability with the help of virtual simulation technology, so as to meet the needs of future industrial development. This paper discusses the significance of the construction of the system, analyzes the difficulties and challenges that may be encountered in the construction process, and evaluates the effective strategies to strengthen the construction of the system. Through the introduction of virtual simulation technology, students can improve their practical skills and innovation ability, and better adapt to the development needs of industrialization and informatization.

Keywords: Integration of production and education; Chemical virtual simulation practice; Teaching system

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1. Introduction

With the rapid development of science and technology and the idea of integration of production and education, the traditional chemical education model has been unable to meet the needs of the industry for high-quality engineering and technical personnel. Under the background of the integration of production and education, the construction of a virtual simulation practice teaching system of the chemical industry has become an important direction of education reform. How to effectively construct and implement the chemical virtual simulation practice teaching system to ensure its educational effect has become a challenge that educators need to face. The purpose of this paper is to discuss this problem and provide a reference for the optimization and development of the chemical virtual simulation practice teaching system.

2. Significance of virtual simulation practice teaching system construction of the chemical industry under the background of integration of production and teaching

2.1. Improving teaching efficiency and quality

Under the background of the integration of production and education, the establishment of the virtual simulation practice teaching system of the chemical industry is particularly important, especially in improving teaching efficiency and quality. Using virtual simulation technology, educators can create a close-to-real chemical process and operating environment, which can accurately simulate various complex situations and challenges in real work, thus providing a safe and risk-free learning platform for students [1]. Virtual simulation technology enables students to have a more intuitive and in-depth understanding of the actual operation process of chemical engineering in addition to theoretical learning. It breaks through the limitation of the separation of theory and practice in the traditional teaching mode and enables students to deepen their mastery of knowledge through simulation practice while understanding theory. The virtual simulation experiment can be carried out at any time and is not limited by physical space and time, which greatly improves the flexibility and efficiency of teaching. Through virtual simulation, students can repeat the experimental operation many times, so as to learn from mistakes and continuously optimize the experimental scheme, which can effectively improve their problem-solving skills and deepen their understanding of the core concepts of chemical engineering [2].

2.2. Cultivating innovation ability and engineering practical skills

The establishment of the chemical virtual simulation practice teaching system plays an extremely key role, especially in cultivating students' innovation ability and engineering practical skills. By utilizing advanced virtual simulation technology, this teaching system is able to build a safe and realistic engineering problem-solving environment. In such an environment, students are free to explore chemical processes and principles and try different solutions to specific engineering challenges. Compared with the traditional teaching methods, this teaching mode of simulation practice provides a unique advantage, that is, it promotes the development of students' innovative thinking. In the virtual simulation environment, students can safely conduct experiments and operations, including those that may pose security risks or high costs in the real environment. Students have the opportunity to face a variety of chemical problems from simple to complex, and more importantly, virtual simulation practice teaching emphasizes the cultivation of engineering practical skills [3]. The practical activities carried out in the simulation environment enable students to familiarize themselves with the planning, execution, monitoring, and optimization process of engineering projects, thus laying a solid foundation for students to become chemical engineers who can solve engineering problems independently in the future.

2.3. Reducing teaching costs and security risks

Traditional chemical laboratories require high investment costs in the purchase, maintenance, and update of experimental equipment, especially some large or high-end chemical experimental equipment. Safety is an important factor that cannot be ignored in chemical experiments. Chemical experiments often involve the reaction of various chemical substances, including some flammable, explosive, and toxic substances, which bring challenges to the safety management of laboratories. Improper operation of the experiment or the failure of the experimental equipment may lead to accidents, which pose a threat to students' safety, and may also bring legal and economic responsibilities to the school and teachers. The construction and application of a virtual simulation laboratory have effectively solved these problems. The virtual simulation laboratory simulates the real chemical experiment process through software, which greatly reduces the demand for experimental equipment and thus significantly reduces the teaching cost. The virtual simulation lab provides students with an absolutely safe learning environment. In the virtual environment, students can freely conduct experimental

operations, even if there is an operation error or experiment failure, it will not cause actual accidents, so as to ensure the personal safety of students.

2.4. Meeting the needs of the education model of integration of production and education

The core of the education model is interdisciplinary integration, strengthening engineering practice and innovation ability training, aiming at cultivating engineering and technical talents with comprehensive literacy and innovative spirit for the future society. Virtual simulation practice teaching conforms to the spirit of this educational model. Through the highly simulated software and platform, the virtual simulation practice teaching of chemical engineering can seamlessly integrate the knowledge of chemistry, physics, mathematics, and other disciplines, providing students with a learning environment that closely combines theory and practice [4]. Virtual simulation practice teaching breaks the space and resource restrictions under the traditional education mode, enabling students to operate complex chemical equipment and processes anytime and anywhere. This flexibility and accessibility greatly enrich the teaching content and methods and improve learning efficiency. Because the virtual simulation environment is highly controllable, teachers can design problems of various levels of complexity, and let students try to solve various challenges that may be encountered in practical engineering in a safe environment, making this experience extremely valuable.

3. Difficulties and challenges in constructing virtual simulation practice teaching system of the chemical industry under the background of integration of production and teaching

3.1. Resource configuration and update challenges

The construction of a chemical virtual simulation practice teaching system under the background of integration of production and education is faced with the major challenge of resource allocation and renewal. Progress in the chemical industry, especially in its technology and processes, is rapid and continuous. The discovery of new materials, the development of new processes, and the improvement of environmental protection and sustainable development requirements have promoted the continuous innovation of chemical technology [5]. Building a virtual simulation system that accurately reflects the latest developments in the industry requires a lot of resources. This includes investments in hardware facilities, such as high-performance computers and specialized software, as well as regular software updates and maintenance costs. With the update of technology, the original virtual simulation models and tools may no longer be applicable, and new models and tools need to be developed to replace them. Together, these factors pose a challenge of resource allocation and updating, requiring educational institutions not only to invest substantial resources in the initial stage but also to prepare adequate budgets and human resources for ongoing updating and maintenance, in order to keep teaching content and methods contemporary and forward-looking [6].

3.2. Connection between teaching content and practical application

One of the challenges in the construction of a virtual simulation practical teaching system of the chemical industry is how to ensure that the teaching content has both theoretical depth and strong practical application, so as to closely meet the actual needs of the chemical industry. The chemical industry itself has a high degree of professionalism and technology, and the technology upgrading speed in the industry is fast, and new processes, materials, and technologies continue to emerge. Incorporating these latest technologies and processes into teaching is not an easy task. The update of teaching materials and course content takes time, and the development of the industry is often rapid, which makes it difficult to update the teaching content in real time. Virtual simulation

practice teaching requires high-quality simulation software and models to simulate real chemical processes, and developing and maintaining these software and models requires a lot of professional knowledge, technical support, and financial investment. From the perspective of students, although virtual simulation practice can provide a certain degree of practical experience, there is still a gap in the real industrial environment. How to effectively simulate the real work scene in the virtual environment, so that students can establish a close relationship between theoretical learning and practical operation, is also a problem that cannot be ignored [7].

3.3. Construction of teaching staff

The construction of a virtual simulation practice teaching system of the chemical industry is facing the great challenge of the construction of teaching staff. At present, most schools lack teachers who have deep professional knowledge of the chemical industry and are familiar with virtual simulation technology. The chemical industry is a highly specialized and technology-intensive field, requiring teachers not only to master professional knowledge of chemical engineering, materials science, process engineering, etc., but also to understand the latest chemical technology and processes. As an advanced educational and research tool, virtual simulation technology includes the understanding and familiar use of a variety of technologies, which have higher requirements for teachers' technical skills [8]. As the direct executor of teaching activities, teachers' professional quality and technical skills directly affect the teaching quality and effect. However, the current teacher training system often focuses more on the in-depth training of a single field, resulting in teachers who are either proficient in chemical professional knowledge but lack the necessary technical support skills, or skilled but lack sufficient background knowledge of the chemical industry. Under this background, it is difficult for teachers to meet the needs of compound talents in virtual simulation practice teaching.

3.4. Student engagement and interactive challenges

It is a big challenge to improve students' participation and interaction in constructing a virtual simulation teaching system of the chemical industry under the background of integration of production and teaching. Although a virtual simulation environment provides a safe and controllable learning platform, the difference between a virtual simulation environment and a real chemical production environment may affect students' learning experience and teaching effect. This gap is mainly reflected in the lack of realism, intuitiveness, and urgency in the simulation environment, which are key elements to promote learning and understanding in realistic chemical production. The real chemical production environment is full of unpredictable variables and immediate problem-solving needs, which promotes students' active learning and improvising skills [9]. Virtual simulation environments are often designed with preset situations and limited interactivity, which makes it difficult to fully replicate this complexity and dynamic nature, resulting in students feeling disconnected from the actual work environment. In real chemical practice, students can deepen their understanding of processes and substances through various sensory experiences such as touch and smell. Virtual simulation environments mainly rely on vision and hearing, which limits the multi-sensory learning experience and may reduce students' sense of participation and interest in learning [10].

4. Strengthening the effective strategies of constructing the virtual simulation practice teaching system of the chemical industry under the background of the integration of production and education

4.1. Integrating resources and building a virtual simulation platform

In order to strengthen the practical teaching system of chemical engineering, the key is to integrate the existing

educational resources and build an efficient and easy-to-operate virtual simulation experiment platform. The construction of this kind of platform is not only a simple aggregation of internal resources of the school but also the use of external high-quality resources [11]. Through this integration of resources, a comprehensive virtual experimental environment can be created, which not only includes the process simulation of chemical reactions but also covers the design of process flow, operation drill of chemical equipment, and other dimensions.

Such a virtual simulation platform can greatly enrich the learning experience of students, allowing them to try and practice in a low-risk simulation environment, so as to gain an in-depth understanding of key technologies and operational essentials in the chemical production process. For example, by simulating a chemical reaction process, students can observe changes in reactions under different conditions and understand reaction mechanisms and control methods [12]. This virtual simulation platform also provides an extremely valuable experiment and research space for teachers and students. Teachers can use this platform to design richer content that is closer to the actual teaching cases, and students can carry out innovative design and research work on this basis, explore new processes, optimize production operations, etc.

4.2. Combination of curriculum system and practice

Under the background of the integration of production and education, the construction of a virtual simulation practice teaching system of the chemical industry is of great significance in improving the quality of education. In order to realize the organic combination of theory and practice, the optimization of the curriculum system is particularly crucial. Virtual simulation practice teaching, with its unique advantages, provides students with a safe and efficient learning environment. In such an environment, students can repeat the experiment an infinite number of times and explore the effects of different experimental parameters on the results, thereby deepening their understanding of chemical engineering principles and processes [13]. This kind of learning method can effectively make up for the shortage of resource limitations and safety hazards under traditional laboratory conditions, and increase the interest and interaction of learning. Virtual simulation practice teaching also supports an interdisciplinary learning model that promotes students' ability to understand and solve problems from a broader perspective. For example, by combining knowledge from multiple fields such as computer science, data analysis, and chemical engineering, students can design and optimize chemical processes in a virtual environment to gain more comprehensive skills and perspectives.

4.3. Hierarchical cultivation of practical skills

The construction of a chemical virtual simulation practice teaching system should focus on the hierarchical cultivation of practical skills, and comprehensively improve students' practical skills and innovation ability through orderly and step-by-step in-depth teaching design. The hierarchical training strategy is based on the current learning progress and personal competency of students, and the content of virtual simulation experiments is carefully designed to ensure that each step of learning can bring new challenges and growth space for students [14]. In the initial stage, the teaching focuses on basic operational training, for example, students will learn basic skills such as chemical equipment operation and material handling and analysis through virtual simulation platforms. The purpose of this stage is to ensure that students can master the basic concepts and operational skills of chemical production, and lay a solid foundation for the subsequent more complex experimental content. With the improvement of students' abilities, the teaching content will gradually transition to more complex process simulation. In this stage, students will face the simulation of the chemical production process in a real industrial environment, involving the comprehensive utilization of raw materials, the optimization of the production process, product quality control, and other aspects. Teaching will guide

students into the training stage of innovative thinking. In this stage, students will be encouraged to apply their knowledge and skills to think creatively and design solutions to complex engineering problems. It can further enhance students' practical skills, and more importantly, cultivate their innovative awareness and problem-solving skills in the face of unknown challenges [15].

5. Closing remarks

In short, the construction of a virtual simulation practice teaching system of the chemical industry under the background of integration of production and education is a complicated but necessary process. By analyzing the significance of its construction, the difficulties and challenges faced, and the effective strategies proposed, this paper aims to provide certain references and guidance for educational reform in the field of chemical engineering and technology. With the continuous progress of technology and innovation of education mode, it is believed that the virtual simulation practical teaching system of the chemical industry will be improved in the future, and provide strong support for training high-quality chemical industry talents.

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References

[1] Li B, Wang Y, 2023, Research on Integrated Teaching Model of Production and Education Under the Background of "Green and Low-Carbon." Guangdong Chemical Industry, 50(22): 196–197 + 205.

[2] Chen L, 2023, Research on Characteristic Teaching of Chemical E-commerce Specialty Under "Integration of Production and Education." Modern Salt Chemical Industry, 50(04): 102–104.

[3] Sun Y, Liu C, Tang Q, et al., 2023, Exploration on Training Mode of Applied Environmental Protection Talents Under the Background of Integration of Production and Education. Guangzhou Chemical Industry, 51(15): 143–145.

[4] Lu Z, Wang P, Zhang J, 2023, Exploration on the Training Model of Application-Oriented Undergraduate Talents in Local Colleges Under the Background of Integration of Industry and Education. Chemical Industry Management, 2023(20): 34–36.

[5] Fu H, Chen X, 2023, Application of Virtual Simulation Technology in the Practical Teaching of Chemical Engineering. Modern Salt Chemical Industry, 50(03): 116–118.

[6] Li Z, Xia X, Sun D, et al., 2023, Construction of Virtual Simulation Practice Teaching System of Chemical Engineering Under the Background of New Engineering. Contemporary Chemical Research, 2023(02): 153–155.

[7] He C, Wang P, Wei S, et al., 2022, Exploration of Multi-Dimensional Teaching Model Based on Virtual Simulation

Practical Teaching Platform of Chemical Industry. Contemporary Chemical Industry Research, 2022(24): 149–151.

[8] Yang H, 2022, Discussion on Three-Dimensional Teaching Reform of Light Chemical Major in Higher Vocational Colleges Under the Background of Integration of Production and Education. Guangdong Chemical Industry, 49(01): 222–223.

[9] Qian G, Zhou S, Duanmu C, 2021, Construction of Heuristic Virtual Simulation Case Teaching System for Integration of Science and Practice in Chemical Engineering. Academy, 14(28): 10–12.

[10] Jin Y, Yuan T, Liu B, 2021, Exploration and Practice of Virtual Simulation Experiment of Chemical Industry Principle. Guangdong Chemical Industry, 48(14): 257 + 259.

[11] Wang Z, Liu G, Liu J, et al., 2021, Construction of Multi-Dimensional Collaborative Virtual Simulation Innovation Practice Teaching System. Laboratory Research and Exploration, 40(05): 197–201.

[12] Xie W, 2021, Application of Virtual Simulation Experiment in Chemical Engineering Principle Experiment. Chemical Engineering Design Communication, 47(03): 124–125.

[13] Ying S, Xie D, Huang J, 2020, Exploration on Construction of Virtual Simulation Practice Teaching System for Chemical Engineering. Laboratory Science, 23(06): 102–104.

[14] Wang T, 2020, Training Methods of Scientific and Technological Innovation and Entrepreneurship of Chemical Students in Colleges and Universities Under the Integration of Industry and Education. Employment and Security, 2020(24): 69–70.

[15] Wang R, 2020, Exploration on Teaching of Coal Chemical Industry Specialty Based on the Background of Integration of Production and Education. Scientific Consultation (Science and Technology · Management), 2020(11): 131.