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Analysis of the Application Countermeasures of Virtual Simulation Technology in Practical Teaching of Chemical Technology Majors in Secondary Vocational Schools

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Abstract: In the practical teaching of chemical technology majors in secondary vocational schools, more and more teachers have begun to apply virtual simulation technology. This digital technology not only provides a safe, practical environment for teaching activities but also breaks the limitations of time and space, allowing students to repeatedly practice complex processes. Based on this, this paper briefly analyzes the application value of virtual simulation technology in the practical teaching of chemical technology majors in secondary vocational schools and the current situation of practical teaching of these majors. It also explores the effective application of virtual simulation technology in practical teaching from aspects such as teaching resources, teaching system, teaching mode, and teacher team construction.

Keywords: Virtual simulation technology; Chemical technology majors; Practical teaching

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1. Introduction

In recent years, the transformation and upgrading of China's chemical industry have accelerated, and the application of digital technology in the chemical industry has become increasingly in-depth. Secondary vocational schools should also keep pace with the times by applying information-based teaching methods such as virtual simulation technology to further improve the quality of practical teaching of chemical technology majors, overcome the limitations of outdated training equipment, limited training venues, and high safety risks in traditional teaching, provide students with more diverse and effective practical learning experiences, and enhance their practical abilities in chemical technology.

2. Application value of virtual simulation technology in the practical teaching of chemical technology majors in secondary vocational schools

2.1. Improving the safety of practical teaching

Conventional practical teaching of chemical technology majors in secondary vocational schools requires completing chemical preparation, instrument operation, and verifying complex chemical unit reactions such as nitration, chlorination, and polymerization through experiments, all of which involve certain safety risks. For example, if students operate high-pressure reactors incorrectly, safety accidents such as poisoning, explosion, and corrosion may occur, threatening the lives of teachers and students [1]. Therefore, for safety reasons, many secondary vocational schools usually cancel or simplify high-risk experimental training in the practical teaching of chemical technology majors. Virtual simulation technology, however, can provide students with a virtual, risk-free practical environment. Breaking the time and space constraints of previous practical teaching, students can repeatedly practice the operation of complex processes and long-cycle workflows in the practical teaching of chemical technology majors, as well as experimental training that is difficult to realize in reality, effectively expanding the depth and breadth of practical teaching.

2.2. Innovating practical teaching processes and methods

Teacher demonstration and student imitation are the most common teaching methods in the practical teaching of chemical technology majors in secondary vocational schools. Students often "cannot see or touch" teaching difficulties during practice and are in a passive learning state. In this regard, teachers can apply virtual simulation technology in teaching to design high-simulation scenarios and interactive tasks for students, transforming them from passive listeners to active explorers. In virtual scenarios, students can "experience" operating equipment and adjusting parameters in real workshops, which can effectively improve their concentration during practice, promote the application of theoretical knowledge to practice, and thus deepen their understanding of professional knowledge [2]. In addition, virtual simulation systems can set practical tasks and work scenarios of different difficulties to meet the learning needs of students at different levels, providing them with targeted and personalized learning experiences.

2.3. Strengthening the integration of production and education in practical teaching

Cultivating high-quality vocational and technical talents who meet the needs of industrial positions is the core goal of secondary vocational education. The use of virtual simulation technology in the practical teaching of chemical technology majors in secondary vocational schools can effectively connect practical teaching with job work, building a bridge between secondary vocational schools and chemical enterprises. Secondary vocational schools can cooperate with chemical enterprises and virtual simulation system development enterprises to jointly develop virtual practical projects for chemical technology majors based on the real production processes, equipment models, and operating specifications of enterprises. This allows students to simulate real job operations in chemical enterprises through online platforms, familiarize themselves with enterprise production processes and job skill requirements in advance, and accumulate "job experience" without going to the front line of enterprises [3]. At the same time, through cooperation with chemical enterprises, teachers of chemical technology majors in secondary vocational schools can also learn about the latest industry trends and technological developments, integrate them into practical teaching, and promote the innovative development of the integration of production and education in practical teaching.

3. Current situation of practical teaching of chemical technology majors in secondary vocational schools

3.1. High loss and cost of teaching resources

Practical teaching of chemical technology majors in secondary vocational schools requires the use of large-scale precision equipment such as distillation columns and centrifugal compressors. The purchase and maintenance of this equipment require huge financial support. Moreover, if students damage the equipment due to incorrect operation during practice, it is easy to incur high maintenance costs. The high cost makes it difficult for many secondary vocational schools to carry out high-frequency practical teaching [4]. For this reason, the content of practical teaching of chemical technology majors in secondary vocational schools is very limited, and students can only conduct practical operations on low-value basic equipment. In addition, some secondary vocational schools have limited teaching resources, and the number of existing equipment and class hour arrangements is difficult to meet students' practical training needs. Even some complex chemical experiments can only be operated by students once or twice. The limited number of practices is not conducive to students forming stable professional skills, nor is it easy to improve their practical operation level.

3.2. Disconnection between teaching content and job requirements

At present, the practical teaching content of some chemical technology majors in secondary vocational schools has the problem of "valuing tradition over innovation" and is disconnected from the actual work content of chemical positions. On the one hand, the current practical teaching content of chemical technology majors in secondary vocational schools lacks job relevance, focusing more on the training of basic operations such as distillation, purification, filtration, separation, and chemical instruments. It does not pay enough attention to the abilities widely used in enterprise operations, such as DCS operation control, quality control analysis and interpretation of chemical plant areas, production line adjustment, routine maintenance and troubleshooting of machinery, etc. As a result, after students enter enterprises, they need to re-learn these contents before they can carry out their work [5]. On the other hand, the practical teaching content ignores the integration of the development trends of the chemical industry and does not fully cover modern chemical concepts such as green chemical industry, safe chemical industry, and intelligent chemical industry, thus failing to meet the demand of chemical enterprises for compound chemical vocational and technical talents.

3.3. Relatively weak "dual-qualified" teacher team

At present, most teachers of chemical technology majors in secondary vocational schools are masters and doctors from university chemical majors. Although they have solid theoretical knowledge, they generally lack front-line work experience in chemical enterprises. They do not have an in-depth grasp of knowledge related to the operation of actual chemical production, facility maintenance plans, process improvement plans, safety management, etc. Therefore, when guiding students' practice, it is easy for students to feel "generalized", and it is difficult to interpret operating principles in combination with industrial reality [6]. At the same time, the insufficient introduction of enterprise tutors is also one of the factors affecting the construction of teachers in chemical technology majors in secondary vocational schools. Chemical enterprises are unwilling to allow core technical personnel to participate in teaching for a long time. Even if they participate, it is mostly in the form of special lectures, making it difficult to deeply integrate into the entire process of practical curriculum design, training guidance, and skill assessment [7]. In addition, teacher training in secondary vocational schools mainly focuses on theoretical improvement, with less systematic training on chemical practical experience and new

process technologies, resulting in teachers' practical teaching ability being unable to keep up with the pace of industrial technological updates.

4. Application countermeasures of virtual simulation technology in practical teaching of chemical technology majors in secondary vocational schools

4.1. Optimizing teaching resources based on virtual simulation practical teaching platforms

In the internet era, more and more teachers have realized the importance of applying virtual simulation technology in the practical teaching of chemical technology majors in secondary vocational schools. At present, the virtual simulation practical teaching platforms used by many chemical technology majors in secondary vocational schools can not only meet the teaching needs of basic experimental teaching and special skill improvement but also cover digital teaching resources such as chemical equipment, process flow, and safety emergency [8]. In practical teaching, teachers should systematically collect, screen, and integrate high-quality teaching resources related to chemical technology, including but not limited to textbooks, cases, and software tools, to build a rich and diverse teaching resource library. Then, relying on specific practical projects, update the version of the virtual simulation practical teaching platform, and construct virtual and physical real teaching resources. This allows students to use online teaching platforms to carry out practical teaching projects required for chemical positions, such as process cognition, start-up and shutdown operations, equipment disassembly and maintenance, and safety emergency handling of different chemical units and different chemical process devices. In addition, teachers should select required teaching software tools such as chemical reaction simulators and process flow simulators according to the characteristics of chemical technology courses. In this process, in addition to internal school teaching resources, teachers should also introduce the latest technologies and materials from the chemical industry and scientific research institutions to ensure that the teaching resources of the practical teaching platform remain advanced and practical. They should also regularly collect students' feedback to further optimize the platform functions and teaching resources [9], so as to provide students with more vivid and effective learning experiences, thereby improving the quality of practical teaching of chemical technology majors and students' practical skills.

4.2. Strengthening the integration of teaching and professional technology and updating the teaching system

In the course introduction stage, make use of the visualization advantages of virtual simulation to display 3D animations and VR scenarios of the macro processes and micro reaction mechanisms of chemical production, such as feeding, gasification, purification, synthesis, and product refining. For example, when teaching the ammonia synthesis process, VR technology can be used to allow students to enter the ammonia synthesis plant to directly understand a series of devices and material flow processes, such as the production, purification, and synthesis of feed gas, overcoming the problem of "difficulty in understanding abstract principles" in previous education [10]. For some high-risk and expensive experimental operation links, such as the feeding/shutdown of chemical facilities and the transportation of flammable and explosive hazardous substances, implement them through the "virtual rehearsal - practical operation strengthening" method. Organize students to practice repeatedly on the virtual simulation platform until they are proficient in operating procedures and correct operation methods.

Finally, after assessment and evaluation, students can complete the experiments in the laboratory when they reach the corresponding level, ensuring operational safety and improving experimental results. In the comprehensive assessment stage, set up virtual comprehensive training projects such as "full-process control and fault diagnosis of chemical production", allowing students to independently complete tasks such as process parameter setting, equipment operation, and abnormal situation handling in virtual scenarios, comprehensively assessing their comprehensive application ability of professional knowledge and skills [11]. At the same time, teachers should develop "small, refined, and practical" virtual simulation teaching resources in combination with the talent training orientation of secondary vocational chemical majors. For example, focus on core skill points such as "handling of cavitation and vapor lock of centrifugal pumps" and "adjustment of reflux ratio of distillation columns" to develop modular virtual practical teaching resources, which is conducive to improving the flexibility of students' practice and their independent learning ability.

4.3. Deepening the integration of production and education based on school-enterprise cooperation and innovating teaching modes

First of all, secondary vocational schools should cooperate with chemical enterprises and virtual simulation technology enterprises to co-construct and share virtual simulation training bases. Enterprises provide production process data, equipment technical parameters, and post-demand standards. Virtual simulation technology enterprises provide technical support, and secondary vocational schools are responsible for the integration of teaching resources and the organization and implementation of teaching, so as to realize the connection between teaching resources and enterprise needs and the consistency between training scenarios and production reality [12]. For example, a secondary vocational school and a local petrochemical enterprise co-built a "petrochemical virtual training base", where students can simulate the full-process operation of petrochemical production, familiarize themselves with the post-operation specifications of enterprises in advance, and lay a foundation for future employment.

Secondly, incorporate chemical qualification certification standards into the virtual reality teaching evaluation system, and use virtual reality technology to carry out pre-examination training and mock exams for vocational qualifications such as chemical general controller and chemical process tester, enabling students to become compound talents who learn professional knowledge while mastering vocational qualification certification knowledge and skills [13]. At the same time, co-organize "virtual skill competitions" with enterprises, taking actual production projects of chemical enterprises as competition content, and competing students' operational skills and problem-solving abilities through virtual simulation platforms. Outstanding competitors can obtain priority employment opportunities from enterprises, realizing the goal of "promoting learning through competitions and promoting employment through competitions."

4.4. Carrying out teachers' virtual simulation skill training and improving teacher team construction

When applying virtual simulation technology to innovate and reform the practical teaching of chemical technology majors in secondary vocational schools, teachers, as key roles in imparting knowledge and skills, their own skills and knowledge level directly affect teaching effects and students' learning outcomes. Therefore, higher vocational colleges should strengthen teachers' training and education to improve their virtual simulation teaching ability [14]. First of all, secondary vocational schools should formulate scientific and reasonable teacher training programs, covering the teaching design ability, curriculum resource development ability, and relevant

teaching management ability of virtual simulation practical teaching for chemical technology majors. Secondary vocational schools can organize workshops, seminars, and other activities to make teachers familiar with the operation process of virtual simulation platforms, master how to design teaching activities suitable for virtual simulation environments, and how to effectively use virtual simulation resources to improve the quality of practical teaching of chemical technology majors. Secondly, in addition to training on teaching skills, secondary vocational schools should also pay attention to the renewal of teachers' teaching concepts. Let teachers transform to a student-centered teaching concept, innovate teaching methods, and stimulate students' enthusiasm for practical teaching [15]. In addition, on-the-job training and academic exchange activities are also effective means to improve teachers' virtual simulation teaching ability. Secondary vocational schools can organize teachers to take on temporary positions in chemical enterprises and front-line factories, allowing teachers to understand the latest development trends of the chemical industry and the application of virtual simulation technology in actual production in practical work. This not only helps teachers better integrate theory with practice but also effectively enriches the practical teaching case resources of chemical majors, thereby providing students with better quality teaching services.

5. Conclusion

In summary, virtual simulation technology has injected new vitality into the practical teaching of chemical technology majors in secondary vocational schools. Its application not only solves many problems in traditional practical teaching but also conforms to the development trend of vocational education reform. In the process of applying virtual simulation technology to carry out practical teaching of chemical technology majors, secondary vocational colleges should adhere to the principles of "student-centered and competence-oriented", take multiple measures to continuously optimize the teaching application path of virtual simulation technology, and thus cultivate more outstanding compound chemical technology vocational and technical talents.

Disclosure statement

The authors declare no conflict of interest.

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