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Practical Exploration of Engineering-Based Training Equipment and Integration of Theory and Practice in Chemical Engineering Education

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Abstract: This paper mainly discusses the practical exploration of the training equipment and integration of theoretical and practical teaching of chemical engineering education, aiming to solve the problems existing in the current higher vocational chemical engineering education such as unreasonable curriculum, lack of innovation in teaching mode, unclear training objectives, and weak practical teaching links. The paper puts forward strategies such as course development based on the integration of practical teaching, course system construction based on vocational skill training, engineering design of practical training equipment based on post-vocational skills, and manufacturing of chemical engineering training equipment based on the enterprise work process, which is conducive to the realization of "combining practical with work" and provides systematic ideas and methods for the innovation and reform of chemical engineering education.

Keywords: Chemical engineering education; Engineering-based training equipment; Practical and theory

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1. Significance of the integration of theory and practical teaching in chemical engineering education and practical training equipment

1.1. Renewing the chemical training equipment

By closely combining the design and manufacture of the practical training equipment with the actual work scenario, comprehensively evaluating and improving the existing equipment, and introducing advanced technical means and materials, the chemical engineering practical training equipment can not only meet teaching needs but also reflect the latest technology and process of the modern chemical industry [1]. The design concept of the integration of practical teaching requires the practical training equipment not only to have the basic teaching function, but also to simulate the complex situation in the real production process. Additionally, in the process of equipment update, enterprises can provide the latest technical data and equipment samples to help schools understand the industry frontier dynamics, ensuring that the training equipment is consistent with market demand. In short, the integration of theory and practical teaching of chemical engineering education and practical training equipment can not only promote the upgrading of equipment, but also enhance students' practical skills and professional quality, training more high-quality technical talents for the chemical industry [2].

1.2. Realizing the "combination of work and study"

"Combining work with study" is an important concept of modern education, emphasizing the combination of theory and practice, and the integration of study and work. Specifically, the introduction of engineering practical training equipment makes the teaching process closer to the actual production process. Students can not only master the basic theoretical knowledge, but also understand and be familiar with various technological processes, equipment operation, and safety norms in chemical production, which not only helps improve students' hands-on ability but also enhances their practical application ability [3]. In addition, the integration of practical teaching emphasizes the student-centered teaching concept and encourages students to actively participate in and explore, which helps stimulate students' interest in learning, cultivate their innovative thinking and teamwork, and lays a good foundation for their future career development.

1.3. Improving students' vocational skills

In the aspect of engineering practical training equipment, the school cooperates with enterprises to introduce advanced equipment and technology, which can simulate the real production environment, so that students can have access to the same equipment and technology as the actual production of enterprises in the process of practical training [4]. In this way, students can not only master the operation skills of the equipment, but also understand the maintenance and troubleshooting methods of the equipment, so as to be more handy in practical work. On the other hand, the integration of science and practice in teaching emphasizes the close combination of theory and practice. In the course design, by combining theoretical knowledge with practical operation, students can deepen their understanding through practical operation while learning theoretical knowledge. In short, chemical engineering education and practical training equipment and the integration of science and practical teaching can make students better adapt to the future working environment and improve their employment competitiveness in the process of combining theory and practice [5].

2. Issues in chemical engineering education in higher vocational colleges

2.1. Unreasonable curriculum setting

From the point of view of the curriculum content, the traditional curriculum of chemical engineering education tends to impart theoretical knowledge, ignoring the cultivation of practical skills. From the perspective of the curriculum structure, the existing curriculum of chemical engineering education pays too much attention to the independence of disciplines and lacks the cross-integration of multi-disciplines [6]. From the perspective of curriculum implementation, there are many deficiencies in the teaching methods of the existing chemical engineering education curriculum. The traditional teaching mode is mainly taught by teachers, with students passively accepting knowledge. There is a lack of active exploration and practical opportunities, which is not conducive to stimulating students' learning interest and innovation ability, and affects their learning effect.

2.2. Unclear training objectives

At present, there is some fuzziness in the training objectives of higher vocational chemical engineering education, which not only affects the effective development of teaching activities but also hinders the all-round development of students' vocational ability [6]. First of all, the training goal fails to fully consider the development trend of the chemical industry and the needs of enterprises, which leads to the disconnection between the cultivated students and the market demand, and it is difficult to adapt to the rapidly changing environment of the chemical industry. Secondly, the training target lacks attention to the individualized development of students, fails to fully stimulate the potential of students, and limits the cultivation of students' innovative abilities and practical skills [7]. Moreover, the training goal fails to grasp the balance between vocational skill and comprehensive quality, overemphasizing the study of theoretical knowledge and ignoring the training of practical skills, resulting in the unbalanced development of students' knowledge and skills, which affects the competitiveness of students' employment.

2.3. Weak practical teaching

In terms of equipment, the practical training equipment used by some schools is old and has a single function, which cannot meet the development needs of the modern chemical industry. This limits students' learning of new technologies and processes and students are unable to obtain the experience matching with the production environment of enterprises in the actual operation process [8]. In terms of practical training content, the design of practical training courses in some colleges and universities lacks systematicity and coherence and is limited to the training of basic operational skills, ignoring the cultivation of comprehensive application ability and innovative thinking. In addition, there is a disconnect between practical training teaching and the needs of enterprises. Some colleges fail to fully investigate the needs of enterprises when formulating practical training courses, resulting in a gap between the content taught and the requirements of the actual production process of enterprises [9].

3. Chemical engineering education training equipment and practical teaching integration strategy

3.1. Curriculum development based on the integration of science and practical teaching

First of all, curriculum development should be student-centered, integrating the needs of the industry and the actual workflow of the enterprise into the teaching content, realizing the "combination of work and study." This means that the course design should not only cover the necessary theoretical knowledge, but also include practical projects closely related to the industry, such as simulated production processes, equipment operation and maintenance, and safety norms. In this way, students can experience a learning situation that is close to the real working environment in class, so as to better understand the application value of knowledge and improve their learning interest and motivation [10]. To ensure that course content is practical and forward-looking, colleges and universities should regularly communicate with industry experts to understand the latest technological development trends and changes in corporate needs, and adjust course content in a timely manner to ensure that it keeps pace with industry development. In addition, curriculum design should also focus on cultivating students' awareness of innovation and teamwork, encouraging students to participate in project-based learning, complete tasks through group cooperation, and enhance their ability to solve complex problems. Secondly, in terms of teaching methods, a variety of teaching methods should be adopted to provide students with a variety of learning experiences. For example, virtual simulation technology can provide students with a safe and controllable practice environment, so that they can carry out operational exercises in a simulated environment and reduce risks in actual operation. In addition, the evaluation method should also be innovative, in addition to the traditional written test, practical operation assessment should also be added, such as skill test, project report, etc., to comprehensively assess students' theoretical knowledge mastery and practical skills, so as to more accurately reflect students' learning results and provide reference for teachers' follow-up teaching [11].

3.2. Construction of curriculum system based on vocational skill cultivation

3.2.1. Theoretical teaching

The courses of theoretical teaching should closely focus on the latest developments in the chemical industry, including core courses such as chemical principles, chemical equipment, chemical technology, safety and environmental protection, etc., to ensure that students have a solid theoretical foundation. At the same time, attention should be paid to the integration of interdisciplinary knowledge, such as chemistry, physics, machinery, and electricity, so as to cultivate students' comprehensive literacy.

3.2.2. Practical teaching

Teachers should make full use of the training bases inside and outside the school to carry out practical activities such as experiments and practical training, so that students can transform theoretical knowledge into practical skills in a simulated working environment. At the same time, the design of practical training projects should be oriented to the actual needs of enterprises, covering chemical production, equipment maintenance, fault diagnosis, safety management, and other aspects. Through project-based teaching, students' hands-on ability and the ability to solve practical problems can be improved.

3.2.3. Training of professional quality

By organizing various club activities, competitions, volunteer services, etc., the school provides students with a platform to demonstrate and exercise their skills, and cultivates students' teamwork, communication, innovation, and professional ethics. At the same time, vocational guidance and employment services should also be strengthened to help students establish a correct career outlook and improve their employment competitiveness.

In a word, the construction of a curriculum system based on vocational skill training requires the joint efforts of schools, enterprises, society, and other aspects [12]. Schools should constantly innovate the teaching mode, optimize the curriculum, and improve the teaching quality. Enterprises should take an active part in personnel training and provide practical opportunities and technical support. Society should provide more career development opportunities for students. Through multi-party cooperation, we should jointly promote the in-depth development of chemical engineering education and practical training equipment and the integration of scientific and practical teaching, and train more high-quality chemical skilled talents.

3.3. Engineering design of practical training equipment based on post-professional skills

First of all, the engineering design of practical training equipment should fully consider the safety, environmental protection, economic, and other factors in the chemical production process. For example, in the design of the reactor, not only the basic reaction function should be considered, but also the safety interlocking device, temperature, and pressure monitoring system should be added to simulate the safety control measures in the real production environment. In addition, the operating cost of the equipment is also an important factor to be considered in the design. Through the optimization of the design, we reduce energy consumption and improve the economy of the equipment, so that students can form a sense of saving resources and improving efficiency in the training process. Secondly, in the engineering design of the practical training equipment, we should also pay attention to the friendliness and intelligence of the operation interface. Modern chemical production increasingly relies on automation and information technology, so the operation interface of the training equipment should try to simulate the control system in the real production environment, using advanced control technology such as touch screen and PLC, so that students can be familiar with the application of these technologies in the training process. In order to ensure that the practical training equipment can truly reflect the complex situation in chemical production, the design should also introduce the concept of interdisciplinary. For example, in the design of the rectification tower, not only the principle of the chemical industry should be considered, but also the multidisciplinary knowledge such as fluid mechanics and heat transfer should be combined to simulate the operation effect under different working conditions, so that students can fully understand various phenomena in the process of chemical production in the training process and improve their comprehensive application ability. Finally, the engineering design of the practical training equipment should also have a certain flexibility to adapt to different teaching objectives and the needs of students at different levels. For example, the equipment can be designed as a modular structure, and different experimental purposes can be achieved by replacing different modules. In this way, it can not only meet the teaching needs of different courses, but also adjust according to the actual situation of students, ensuring that every student can get sufficient training and improvement in the practical training process.

3.4. Process-oriented chemical training equipment manufacturing based on the enterprise work

First of all, it is necessary to conduct an in-depth study of the production process of the enterprise to understand its key links and operation points. Through field investigation, expert interviews, and data analysis, first-hand information about the production process of the enterprise is collected. On this basis, combined with the teaching objectives of the chemical engineering major, the main functions and performance indicators of practical training equipment are determined. For example, the teaching goal of cultivating students' operation skills is clearly defined. The equipment should have the function of simulating the operation of common chemical equipment, so that students can carry out practical training [13]. Next, the design stage is the core of the entire manufacturing process. The design team should be composed of engineers, education experts, and teachers with rich practical experience to ensure that the design can meet the teaching needs and reflect the actual business. During the design process, the safety, reliability, and maintainability of the equipment should be fully considered. For example, the equipment should have a perfect safety protection mechanism to prevent students from accidents during operation. At the same time, the equipment should be easy to disassemble and assemble, and convenient for teachers to maintain and update. Moreover, the manufacturing stage needs to choose the right materials and technology to ensure the performance and quality of the equipment. During the manufacturing process, the design specifications should be strictly followed, and multiple tests and debugging should be carried out to ensure that the functions of the equipment can operate normally [14]. Finally, during the installation process, the operation manual should be strictly followed to ensure that all parts of the equipment can be correctly installed. The debugging phase requires a comprehensive test of the equipment, including functional testing, performance testing, and safety testing, to ensure that the equipment can operate normally under various conditions. In addition, the installation and commissioning team should also provide detailed instructions and technical support for teachers and students to ensure that they can master the use of the equipment [15].

4. Conclusion

In conclusion, practical training equipment in chemical engineering education and the integration of practical teaching can effectively improve the current situation of chemical engineering education in higher vocational colleges. By emphasizing the importance of continuous optimization of teaching mode, strengthening school-enterprise cooperation, and deepening the integration of production and education, a multi-party cooperative education mechanism will be formed under the joint efforts of educational institutions, enterprises, and all sectors of society to provide strong support for training more high-quality chemical technical talents and promote the comprehensive development of chemical education.

Disclosure statement

The author declares no conflict of interest.

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