Exploration on Course Reform of "Discipline Competitions Training for Applied Chemistry" in Excellent Engineer 2.0 Construction

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Abstract

The specialized course "Discipline Competitions Training for Applied Chemistry" offered by the Applied Chemistry major of our university can actively respond to the new demands of digital economic development, comprehensively enhance the construction of the new engineering education training system, and expedite the professional construction of the Jiangsu Province Excellent Engineer Education and Training Program 2.0. Centering on national-level A-class competitions such as the National Chemical Engineering Design Competition and the National Chemical Experiment Competition for College Students, it adheres to the principle of "promoting teaching through competitions, promoting learning through competitions, promoting reform through competitions, promoting construction through competitions, and integrating competitions with courses", and conducts reform and exploration in aspects such as course content, facilities, and the teaching staff. Remarkable achievements have been attained, with rich outcomes in discipline competitions, a high degree of attainment of professional training goals, an excellent matching employment rate, outstanding comprehensive quality of graduates, and a high satisfaction rate from employers. Through the reform of this course, students' innovative capabilities and practical abilities have been enhanced, their teamwork awareness and cooperative abilities have been strengthened, their autonomous learning interests and enthusiasm have been mobilized, and their scientific thinking abilities and innovative consciousness have been trained.

Keywords: Applied Chemistry, Discipline Competitions Training for Applied Chemistry, Excellent Engineer 2.0 construction, course reform.

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1. Introduction

To proactively respond to the new demands of digital economy development, comprehensively enhance the construction of the new engineering education system, be based in Yancheng, serve Jiangsu Province, integrate into the Yangtze River Delta region, and align with the national strategy of coastal development, it is highly necessary to accelerate the professional construction of Jiangsu Province's Excellent Engineer Education and Training Plan 2.0 [1], systematically plan the construction and development of disciplines and specialties, and cultivate outstanding engineering and technological talents that meet the demands of multiple entities such as the government and the market. In line with the principle of "promoting teaching through competitions, promoting learning through competitions, promoting reform through competitions, promoting construction through competitions, and integrating competitions and courses", we have increased attention to disciplinary competitions related to the applied chemistry major, optimized the competition preparation process, facilities, and faculty team. Our university has offered the course "Training for Applied Chemistry Disciplinary Competitions". This course belongs to the innovation and entrepreneurship practice courses in the talent cultivation plan and is offered in the sixth semester. It is a characteristic course of the applied chemistry major in our university. The reform exploration of this course mainly consists of four aspects: reform of the course content, reform of facilities, reform of the faculty team, and the reform effects. The reform exploration of this course can enhance students' innovation and practical abilities, strengthen their teamwork awareness and cooperation capabilities, stimulate their autonomous learning interest and enthusiasm, and train their scientific thinking ability and innovation consciousness [2].

2. Curriculum content reform

This course mainly focuses on national-level Class A competitions such as the National Chemical Engineering Design Competition for College Students and the National Chemical Engineering Experiment Competition for College Students. It comprehensively applies the knowledge of relevant professional courses for chemistry majors from the first to the third year of college and conducts targeted disciplinary competition training. Through the training content, students can deepen their understanding and mastery of previous knowledge, thereby providing feedback on the learning content of related professional courses and improving the postgraduate entrance examination and employment rates of students [3]. Therefore, the reform of the course content is of great significance. In the process of gradual exploration, the current content of this reformed course mainly includes the following.

2.1 Process control and automation theory training

This training mainly covers basic concepts of automatic control systems, mathematical models of controlled objects, detecting instruments, sensors, and actuators, control laws and parameter tuning of automatic control instruments, simple control systems, and complex control systems, etc. The training aims to understand the research objectives and prospects of automation control, review the content and learning methods of process automation and instruments courses, grasp the basic composition of automation control processes, be familiar with the basic knowledge related to control, and understand and master the characteristics and applications of cascade, uniform, ratio, and feedforward control systems. The explanation of control system control schemes solves the problem of how to implement control schemes in engineering. This part of the content explains the relationship between theory and practice, improves students' logical thinking and dialectical thinking ability, cultivates students' scientific attitude of combining theory and practice, and further realizes that practice is the only standard for verifying truth.

2.2 Chemical design basic theory training

This training mainly covers process flow design, material balance and heat balance, process equipment design, plant layout design, and piping design. The training aims to understand the importance and significance of chemical design, master the basic principles and methods of material and heat balance in chemical processes, process flow design, and the design of typical equipment's control flow, as well as the requirements for drawing process flow diagrams and compiling design specifications. This part of the content cultivates students' design philosophy of seeking truth and being practical, rigorous, responsible, coordinated, and innovative work style, improves their ability to analyze and solve problems with the knowledge they have learned, and enables them to consider technical problems from an engineering and economic perspective, gradually realizing the transformation from college students to chemical engineers.

2.3 Engineering drawing and CAD theory training

This training mainly covers basic knowledge and skills of drafting, computer drafting, PID process flow diagram and PFD process flow diagram, etc. The training aims to understand the basic requirements of the national drafting standards for mechanical drawings, including paper size and format, scale, font, and line type, master the use of drawing tools, be familiar with the relevant provisions on dimensioning, learn to set up the drawing environment, create and edit two-dimensional drawing commands and editing commands, define block attributes and use external references, create and edit pattern fill objects, dimensioning, and drawing of assembly drawings, and be able to draw engineering drawings using computer software. AutoCAD is a way to express engineering drawings using computer drafting with high efficiency, which has strong practicality and applicability. This training is conducive to cultivating students into engineering technical talents with a balanced knowledge and ability structure. By mastering the basic commands of AutoCAD and the ability to use them flexibly, we can train students' spatial imagination ability and certain analysis and expression ability, and cultivate their meticulous and rigorous work style.

2.4 Chemical computing and software application training

This training mainly includes full-process software simulation, energy separation process software simulation, equipment process calculation software simulation, and SmartPlant 3D, etc. The training aims to understand the importance and significance of chemical calculation and software application, master the use of Aspen plus and process route determination, master the material and heat balance in Aspen plus, and master the use of SmartPlant 3D. The "craftsman spirit" is used as the main line throughout the classroom teaching activities, requiring students to pay attention to details in computer simulation and be meticulous and strive for perfection. In the simulation of process route design, the teacher guides students to establish an honest and responsible professional ethics view. In the simulation of equipment selection, the importance of practice is explained, and students are taught to find answers from practice. Through this course, students will improve their comprehensive understanding of chemical calculation and software, increase their interest in chemical calculation, and consolidate their professional outlook.

2.5 Chemical principle experiment training

This training mainly includes the comprehensive experiment on the performance and fluid flow resistance of centrifugal pumps, the determination of constant pressure filtration coefficient and washing experiment, the comprehensive experiment on distillation and the absorption comprehensive experiment, etc. The training aims to master the operation skills of typical unit equipment, be familiar with the basic testing methods and instrument selection and application of chemical data, master the experimental research method and related data processing method of engineering problems, master the ability to correctly analyze, discuss and summarize the experimental results and write an experimental research report in simple words and appropriate charts. Students can deepen their understanding of the basic knowledge of chemical engineering principles through different unit operations experiments, master the basic operation skills of typical unit equipment, be familiar with the basic testing methods and instrument selection and application of chemical data, master the experimental research method and related data processing method of engineering problems, thereby cultivating students' rigorous scientific attitude and engineering concept, cultivating students' ability to solve complex engineering problems by integrating basic knowledge and professional knowledge, improving students' independent thinking ability and innovation ability, enhancing students' safety awareness and team cooperation awareness, and laying a foundation for students to engage in scientific research, technical development and actual engineering work in the field of chemical engineering and related fields.

2.6 Chemical simulation experiment training

This training mainly includes chemical unit simulation operation, ethyl acetate production pilot simulation training, process production simulation training, chemical equipment operation and simulation training. The purpose of the training is to understand the importance and significance of chemical simulation experiment, master the use of simulation software and the determination of parameters, and the treatment of problems in the simulation process.

2.7 Process Automation and Instrumentation Experiment Training

This training mainly encompasses single (double) tank level fixed-value control experiment training, three-loop level cascade control experiment training, double-loop flow ratio control experiment training, and feedforward-feedback control experiment training for the liquid level of the lower tank, among others. The objective of this training is to master the engineering implementation of control system schemes and the engineering tuning of control system parameters, and to comprehend the relationship between automated control systems and engineering safety production. Through the elaboration and experimentation of control system control schemes, the issue of how to implement control schemes in engineering has been addressed. It expounds on the relationship between theory and practice, enhances students' logical and dialectical thinking capabilities, nurtures students' scientific attitude of integrating theory with practice, and further recognizes that practice is the sole criterion for verifying truth.

2.8 Chemical Engineering Design Competition Training

This training primarily consists of the comparison and selection of process flows, the self-control process of typical equipment, relevant contents of environmental assessment and safety assessment, as well as the introduction of competition knowledge. The training aim is to master the fundamental principles and methods of process flow design, the design methods of the self-control process of typical equipment, and the drawing requirements of process flow diagrams and the compilation methods of design specifications [4]. Cultivate the habit of strictly adhering to various standard regulations, foster good professional ethics, and develop a serious, responsible, down-to-earth work attitude and a rigorous, meticulous learning and working style

3. Condition Facility Reform

3.1 Hardware Facility Reform

For the "Chemical Science Competition Training" course of the Applied Chemistry major, in addition to the experimental apparatuses related to professional courses, the college has added a digitalized chemical process micro-factory training room - the ethyl acetate production training platform. Practical operations can be conducted on various forms of equipment, instruments, valves, pipe fittings, and different control systems, deepening students' understanding of relevant theoretical courses and ameliorating conditions such as the shortage of engineering training projects, insufficient hands-on opportunities during factory internships, an incomplete professional practical teaching system, and students' inability to quickly adapt to enterprise work after graduation. Simultaneously, the relevant equipment of the chemical virtual simulation laboratory has been optimized. This constitutes an effective and significant supplement to practical teaching in the context of educational informatization, effectively resolving the problem of limited practical opportunities for students during enterprise internships. It can exercise students' independent conception and design capabilities, stimulate their interest in learning, and is conducive to cultivating talents with innovative spirit and practical abilities.

3.2 Software Facility Reform

In light of the current genuine technologies and processes in production and services, a knowledge education system is constructed to advance the practical teaching segments of "virtual assistance for the real, and the combination of the virtual and the real". The virtual simulation software in the chemical virtual simulation laboratory is updated, and the virtual simulation of chemical production practice is established based on 2D or 3D technology, thereby enhancing students' production practice capabilities [5]. The introduction of chemical virtual simulation experimental training alters the teaching mode and approach of chemical practical teaching, effectively addressing the issue of students having limited practical operation opportunities during enterprise internships.

4. Teacher Team Reform

Integrating the goals and tasks of Jiangsu Province's Excellent Engineer Education and Training Plan 2.0 for professional construction, the teacher team of the "Chemistry Subject Competition Training" course is adjusted and optimized. Firstly, a composite teacher team is established. The teacher team is composed of full-time teachers from different majors and enterprises within the school and part-time industry teachers. The division of labor is clearly defined. The combination of on-campus and off-campus teachers can better integrate theory and practice, adhering to the principle of "theory - practice - competition - theory", commencing from theoretical knowledge and ultimately achieving deeper theoretical feedback through competitions, enhancing students' comprehension of subject competition theory and operation. Secondly, the qualifications and age distribution of the teacher team are optimized. All teachers in the team possess doctoral degrees or senior professional titles and simultaneously include teachers from the 1960s, 1970s, 1980s and 1990s, achieving high qualifications and a balanced age structure with mutual assistance among different age groups. Finally, the collective lesson preparation mode of the teacher team is strengthened. In light of the specific circumstances of various competitions in the previous year and in combination with the latest technologies and theories related to the content, a concentrated discussion for lesson preparation is conducted at the beginning of the semester. The latest teaching plans and contents are compiled, and regular teaching and research activities are carried out.

5. Reform Achievements

5.1 Abundant Outcomes of Subject Competitions

Students majoring in applied chemistry have participated in various subject competitions and achieved numerous prestigious awards, exerting a significant social influence and receiving wide recognition. In the past five years, they have won five second prizes and five third prizes in the National Chemical Engineering Design Competition for College Students, five first prizes and five second prizes in the East China Region, six special prizes, four first prizes and 35 second prizes in Jiangsu Province. They have also obtained four first prizes and five second prizes in the East China Region of the National Chemical Experiment Competition for College Students.

5.2 High Degree of Achievement of Professional Training Goals and Excellent Job-Oriented Employment Rate

Based on the employment data feedback from the Jiangsu Provincial College Enrollment and Employment Guidance Service Center, among the 261 students who graduated in the past three years from this major, the employment rate reached 96%, and the job-oriented employment rate exceeded 88%. Among them, the proportion of those pursuing master's degrees related to the major was 30.6%, ranking among the forefront of similar colleges and universities in the province. The proportion engaged in industries related to chemical and environmental protection production was 57.6%. The employment positions of graduates are highly relevant to the training goals of this major.

5.3 Excellent Comprehensive Quality of Graduates and High Satisfaction of Employers

Through statistics from questionnaires distributed to employers by a third party, employers have highly evaluated students' professional basic knowledge, innovation ability and practical operation ability, with an overall satisfaction rate of up to 92.7%. More than 90% of employers expressed satisfaction with their professional ethics, work attitude, adaptability, organizational and management ability, professional knowledge and skills, innovation ability and learning ability.

6. Conclusion

The "Chemistry Subject Competition Training" course, a characteristic course established by the applied chemistry major of our school around national A-level competitions such as the National Chemical Engineering Design Competition and the National Chemical Experiment Competition for College Students, can proactively respond to the new demands of the digital economy. It comprehensively strengthens the construction of the new engineering education system, accelerates the professional construction of Jiangsu Province's Excellent Engineer Education and Training Plan 2.0, adheres to "promoting teaching through competitions, promoting learning through competitions, promoting reform through competitions, promoting construction through competitions, and integrating competitions and teaching". Reforms and explorations have been conducted in aspects such as course content, conditions and facilities, and the teacher team, which have enhanced students' innovation and practical abilities, strengthened their team spirit and cooperation capabilities, stimulated their independent learning interest and enthusiasm, and trained their scientific thinking ability and innovative consciousness. The achievements of the course reform are remarkable, with rich results in discipline competitions, a high degree of achievement of professional training goals, an excellent job-oriented employment rate, excellent comprehensive quality of graduates and high satisfaction of employers.

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