Exploration and Practice of Virtual Simulation Experiment Teaching in the Cultivation of Ship Painting Talents

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Abstract. With the rapid development of higher education in the new era, virtual simulation technology has been continuously integrated into various education and teaching. This paper briefly analyzes the application of the new experimental teaching mode of "Internet + experimental teaching" constructed by virtual experimental project design, network technology, multimedia technology and human-computer interaction technology in the training of marine talents. The combination of virtual simulation teaching and practical operation not only improves the application skills and innovation ability, but also improves the measures of ideological and political education for ship painting talents, and builds a ship painting talent training mode based on ship painting talents. The "Virtual Simulation Experiment Teaching Platform" will provide a reference for improving the training quality of ship painting talents.

Keywords: Ship coating · Virtual simulation · Teaching reform · Talent training · Course ideology and politics

1 Introduction

Ship painting is one of the important processes in shipbuilding, and specialized painting technology talents with solid professional basic knowledge, high comprehensive quality and innovative development potential are the talents urgently needed by the shipbuilding industry. Talent installation is a necessary link, but due to the large site, high equipment investment, complex technological process, and high requirements for teacher qualifications, the practical training link has not been effectively implemented. Since my country officially launched the construction of a national-level virtual simulation experiment teaching center in 2013, various colleges and universities have responded to the call of the national policy to start the construction of virtual simulation experiment projects, and have actively explored course experiments [1, 2]. To crack the ship, the problem of painting talent provides an effective solution. The main purpose of virtual simulation experiment teaching is to adapt to the revolutionary changes in the way of knowledge acquisition and transmission, and the relationship between teaching and learning under

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the conditions of informationization, deepen the deep integration of information technology and education and teaching, and take "openness, sharing, and interaction" as the basis. The main feature has gradually become an important means to broaden the depth and breadth of teaching content, extend teaching space and time, and improve teaching quality. Expressing experimental content and simulating the actual experimental process in various forms such as virtual simulation technology, animation technology, and physical display technology is conducive to improving students' interest in learning, mobilizing students' enthusiasm, and cultivating students' innovative ability and practical ability, etc. [3–6].

2 Problems Faced by Ship Coating Teaching in Talent Training

Ship coating is the most important means of ship anti-corrosion and anti-fouling. Since each part of the hull has been in different corrosive environments for a long time, the requirements for different parts of the hull are different. Ship painting should also be adapted to the entire shipbuilding process, and should run through the entire process from ship design to construction. It should be said that without modern ship green painting, there can be no modern green shipbuilding. The ship painting optimization design experiment aims to cultivate students' knowledge integration ability, practical innovation ability and industry adaptability. (1) Difficult to replicate ship painting scene. (2) The operation of paint experiments requires corresponding professional qualifications and employment certificates, and neither teachers nor students can meet the basic safety requirements. (3) Coating experiments need to continuously upgrade professional equipment and tooling, consume a lot of experimental materials such as coatings, and the experimental cost is high [7].

3 Background of the Virtual Simulation Experiment Project of Ship Painting in the School of Environmental Engineering, Jiangsu University of Science and Technology

Jiangsu University of Science and Technology, as the only industry-specific university in Jiangsu Province that mainly serves the shipbuilding and marine engineering equipment industry, is dedicated to serving the country and fostering profound professional theoretical foundations, interdisciplinary knowledge integration capabilities, practical innovation capabilities, and industry adaptation. High-level application-oriented talents with strong ability and patriotism who are willing to contribute in difficult industries are the unswerving mission of the school.

The School of Environmental and Chemical Engineering of Jiangsu University of Science and Technology has carried out personnel training and scientific research in the fields of ship corrosion and protection, ship green antifouling agent, and intelligent monitoring and control of ship pollutants, and has formed distinct ship and marine characteristics. The applied chemistry major and the environmental engineering major focus on the knowledge, ability and quality needs of chemical and environmental talents formed by the green ship manufacturing industry chain, dynamically optimize the talent

Table 1. Award information

Serial Number	Award Category	Award grade	Topic	Year
1	Jiangsu province teaching achievement prize	First prize	Exploration and practice of "Chem+" compound innovative talent training mode	2017

training plan, continue to deepen the reform of education and teaching, and have been approved as two national first-class undergraduates. As a professional construction point, the college's exploration and practical achievements around the compound innovative talent training model won 1 first prize of the Jiangsu Provincial Teaching Achievement Prize (Table 1).

Relying on the National Experimental Teaching Demonstration Center of Ship and Ocean Engineering of Jiangsu University of Science and Technology and the Ship Virtual Simulation Experiment Center of Jiangsu University of Science and Technology, the college integrates "virtual reality + Internet" technology into the experimental teaching project of ship painting, and creates a "virtual ship green painting process". "Simulation Experiment" was recognized by the Ministry of Education as a first-class course for virtual simulation experiment teaching. As shown in Fig. 1, the course adheres to the principle of "student-centered", faces the shipbuilding and marine engineering industry, highlights the key technologies of green painting, and in accordance with the principle of "being true to reality, combining fiction and reality, and complementing each other", relying on the existing physical teaching and research platform, combining the teacher's research Definition 1. For two subsystems with survivability associations in large-scale network, there exists the following equation direction and the achievements of "production, learning and research", combined with the introduction of the latest achievements in the development of the national shipbuilding industry, developed a virtual simulation experiment project of ship green painting process, which effectively solved the high cost, high risk and difficulty of repeated operation of conventional experiments. To achieve the purpose of reducing internship costs and shortening teaching time, realize the open sharing of simulation teaching platform, better combine theory with practice, realize the organic integration of information technology and characteristic professional education experiments, and give full play to students' subjectivity. Cultivate students' innovative ability, organically integrate ideological and political elements such as patriotism, mission, dedication, etc., improve students' comprehensive quality, and make important contributions to cultivating high-quality engineering application-oriented innovative talents.

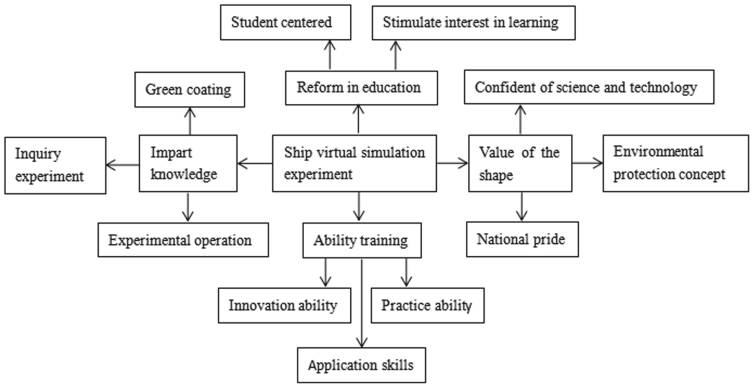

Fig. 1. Schematic diagram of the training of high-quality engineering application-oriented innovative talents led by virtual simulation.

4 Design Idea of Virtual Simulation Teaching Scheme for Ship Coating Personnel Training

In view of the difficulties faced by ship coating experiments at present, the teaching scheme of virtual simulation experiment system consists of five modules: familiarity with ship cabin structure, coating type selection, spraying process parameter design, spraying construction simulation and performance testing. The system covers the courses of "Coating Chemistry", "Marine Coatings and Coating Technology", "Coating Materials and Technology", etc., and sorts out the selection and design of different cabin coatings, spraying process parameter design, spraying construction simulation and spraying process exploration. Four experimental links, so that students can systematically master the principles of mainstream advanced coating technology, process design methods, and experimental analysis methods. Through virtual simulation experiment teaching, this paper aims to solve four problems in the training of ship painting talents: (1) it is difficult for students to arouse their interest in practical knowledge exploration from the interaction, immersion and presence of real scene simulation practice; (2) It is difficult to experience the complexity of coating process and completeness of process from the practice of the whole process; (3) It is difficult to achieve autonomy of learning from different parts of paint design, different parts of spraying process parameters design, spraying construction process selection, performance testing comparison; (4) It is difficult to feel the hardship of the industry from the experience of the complex and difficult environment of the hull and feel the sense of honor of the development of the national shipbuilding industry from the advanced ship painting design.

4.1 Emphasize the Systematization of the Knowledge System

This experiment covers typical links in the complete process from experiment preview, paint type selection, spraying process parameter design to performance testing, and the technical system is complete. It is necessary to master a large number of knowledge points of spraying technology, explore the design method of ship spraying process,

and learn the analytical ability for practical engineering problems, so as to achieve the purpose of comprehensively and systematically cultivating students' knowledge system and practical ability.

4.2 Highlight the Exploratory Nature of Technical Methods

Students independently design the process, design reasonable process parameters to conduct simulation experiments, and optimize the process according to the results. This exploration process reflects the cultivation of engineering practice ability and innovation ability to explore the optimal process for engineering problems. Repeated experiments are carried out under the guidance of the specific process parameters, and there is a lack of exploratory problems. The parameters set by each student are different, and the results obtained will also be different. This setting of one person and one machine stimulates students' spirit of exploration.

4.3 Highlight the Concept of "Student-Centered" in Teaching Methods

This experiment adopts the method of one person and one machine as shown in Fig. 2. Students can analyze and solve problems independently according to the knowledge they have learned, so as to inspire students to adopt more reasonable experimental plans and obtain the best experimental results. The combination of information technology, virtual simulation technology and experimental design can accurately and intuitively reflect the design effect of each step in real time, shorten the experimental period and reduce the experimental cost. This improves students' autonomous learning ability, realizes the organic combination of information technology and characteristic professional education experiments, and improves the quality of practical teaching and education level. Students can learn and review the content of this project at any time wherever there is an internet connection. It is highly flexible and practical. It extends and expands traditional learning methods. These methods make "student-centered" teaching possible. The idea was developed so that the degree of systematic mastery of knowledge could be assessed. In addition, students also need to analyze the experimental results in the experimental report, and conduct an in-depth analysis of the description of the problem, the reasons for the formation of the results, and the improvement measures. The teacher evaluates the experimental report in the background, so as to evaluate the analysis of students' problems ability.

4.4 Highlight the Organic Integration of Curriculum Ideological and Political Education

In the design of virtual simulation experiments, the teaching of basic theoretical knowledge of the system is always combined with the introduction of new technologies and techniques, and the cultivation of students' independent analysis and problem-solving ability is combined with the improvement of practical ability. Innovation ability can enhance the subjectivity of students' in-depth participation, and in the module design, the organic combination of ideological and political elements of the curriculum is strengthened. Through the application of painting technology on the national heavy equipment

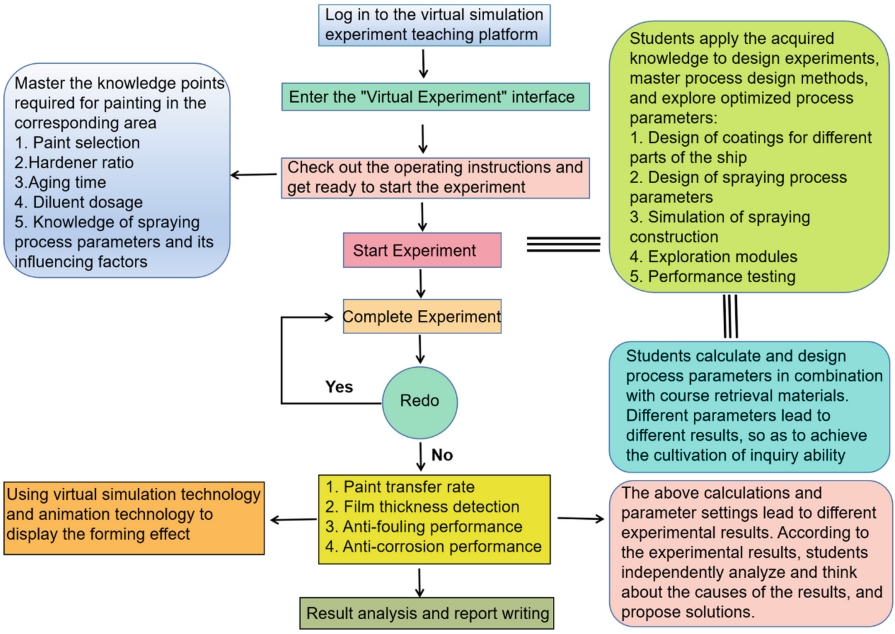

Fig. 2. Schematic diagram of virtual simulation experiment teaching of ship green coating process.

independently developed by my country - special ships and advanced ships, students can deeply understand the spirit of independent innovation in my country's science and technology, enhance their sense of national pride and identity, and inspire them to establish scientific and technological self-confidence. At the same time, the realistic reproduction of the arduous and complex environment of ship painting can cultivate students' professionalism and sense of responsibility for ship painting talents, so that students have a sense of responsibility and mission to serve the country.

5 Training Goals for Ship for Ship Painting Talents

In the design of the ship painting virtual simulation experiment project, both theory and practice, knowledge and ability, commonality and individuality are combined, and a special painting technology with solid basic knowledge, strong practical ability, high comprehensive quality and innovative development potential has been established. The goal of the curriculum system for talents.

5.1 Improve the Depth and Breadth of Students' Comprehensive Mastery of System Knowledge

The system design of the virtual simulation experiment module completely builds the knowledge pedigree of ship painting, changes the traditional teaching mode to an independent participation and interactive feedback mode, so that students can invest in relevant theoretical knowledge in a higher dimension and deeper. In this high-level inquiry-based learning, students systematically master the systematic theoretical and practical knowledge of ship painting.

5.2 Improve Students' Innovative Ability of Independent Thinking

Students must innovate according to their own ideas, design or combine by themselves, and update a large number of experimental parameters, exercise hands-on ability and innovative thinking.

5.3 Improve Students' Ability to Solve Problems in Practice

According to the current talent demand trend, give full play to the advantages and characteristics of the shipbuilding industry, and on the basis of systematic experimental training, enable students to obtain comprehensive quality training and improvement in a certain aspect according to their own conditions and conditions. Experiments can deepen students' perceptual understanding, and the experimental process is close to the actual painting and debugging process, so as to cultivate students' practical ability.

5.4 Shaping the Value and Mission of Students

Through the organic integration of the ideological and political elements of the course, the ideological and political education of the course is seamlessly connected with the course teaching, and the students' immersive integration into the ship painting industry is enhanced in the virtual simulation teaching. Taking the contribution of Jiangsu University of Science and Technology students in the construction of domestic aircraft carriers, Type 055 destroyers, new nuclear submarines, etc., the school's "ship soul spirit" is shaped into professional course teaching, and the sense of industry mission and social responsibility of ship painting talents is enhanced.

5.5 Cultivating Students' Industry Competencies

The ship painting virtual simulation experiment project is shared with the industry and enterprises to promote the innovation of teaching forms. Effectively solve the problem that students are difficult to practice in shipyards and less practical training in the process of theoretical and practical teaching. Through the simulation demonstration of engineering physical equipment through virtual simulation technology, it helps students to better understand the relevant process principles, operating environment, process and control system, and allows students to select coatings and design coating process parameters. Solid mastery and integration of other courses. After completing relevant

Table 2. Scope of key parameters of each link

Parameter	Range
The Nozzle Aperture	0.43–0.78 mm
Spray Pressure	8–18 Mpa
Spray Distance	0–600 mm
Jet Angle	60°–120°
Spray Speed	0–80 cm/s
Spithead Ypype	Type B and C type nozzle
Film Thickness	0–250 μm
Spacing Interval	0–18 h
Two-component Coating Curing Ratio	1:1, 2:1, 3:1 and 4:1
Curing Time	0–1 h
Spray Degree	0, 1 and 2

theoretical courses, students can systematically and completely master the setting of coating parameters (Table 2), so as to better adapt to the development and needs of the industry.

5.6 Highlight the Innovation of the Talent Training and Evaluation System

Since this project supports exploratory experiments, students optimize the process parameters through multiple experiments, and the system background will completely record the entire experimental process of the students, and make objective evaluations based on the final optimization results and optimization times, so as to evaluate the exploration ability of the evaluation process method and avoid The phenomenon of plagiarism can be avoided.

5.7 The Implementation Effect of Virtual Simulation Teaching in the Training of Ship Painting Talents

Through the virtual practice environment and practice platform, it can make up for the deficiencies that traditional practice students cannot complete by themselves. The simulation demonstration of engineering physical equipment through virtual simulation technology can help students better understand related process principles, operating environment, process and control systems. This can not only enhance students' hands-on ability, practical ability and engineering awareness, but also enhance their sense of national pride and identity. Since the implementation of the virtual simulation experiment project for two years, 2,547 students have participated in the practical operation and learning of the project, and 94.7% of the students have independently completed the design of paint and coating process, and completed the experiment content. We got the answer and collected experimental data efficiently. In the student feedback evaluation,

87.3% of the students believed that the design capabilities of paint selection, curing agent ratio, curing time, thin agent selection and coating compatibility for different parts of the ship have been significantly improved.

6 Conclusions

Our school's ship painting virtual simulation experiment system is based on the open virtual simulation experiment teaching management platform. Adhere to the principle of "combining the virtual and the real, complementing each other, and not being false and not real", aiming at the relevant industry needs, students' professional interests, and the cultivation of practical and engineering practice capabilities, and improve the simulation technology of professional virtual equipment and graphic drawing visualization. In the simulation layer, 3D simulation modeling and simulation design of the scene, experimental equipment, instruments and other main related elements, through "test preview", "coating design", "spraying process", "spraying" to complete the experimental "construction", "Test exploration" as one of the full-process closed-loop implementations. The parameters of the experimental conditions and experimental data are analyzed through the data layer, and stored in a comprehensive database with massive data management capabilities through the security management identity authentication of the support layer. At the application layer, both teachers and students can conduct subsequent learning summary, online communication, management and maintenance statistics through the open virtual simulation experiment teaching management platform of the virtual simulation platform. The construction of the ship painting virtual simulation experiment project solves the technical problems encountered in the traditional practice, and is of great significance for cultivating high-quality engineering application-oriented innovative talents.

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References

1. B. Wang, C. L. Qin, Y. F. Liu, et al. Construction and Application of a Virtual Simulation Experimental Teaching Center for Chemistry and Chemical Engineering. University Chemistry, Vol. 37, pp. 138–145, 2022.
2. H. B. Liu , J. Shen, G. Wang, et al. Construction of virtual simulation experimental teaching resource platform based on engineering education. Experimental Technology and Management, Vol. 36, pp. 19–22, 2019.

3. Y. X. Xue, H. F. Zhang, L. Q. Han, et al. Application of virtual simulation experiment teaching platform in the cultivation of innovative and entrepreneurial talents in pharmacy. Journal of Jilin Medical College, Vol. 41, pp. 473–474, 2020.
4. H. L. Hu, T. Wang. Virtual simulation experiment helps undergraduate teaching of electrical engineering and automation. Chinese Journal of Multimedia and Network Teaching (Early Issue), Vol. 10, pp. 7–9, 2020.
5. W. W. Dong, G. C. Li, C. X. Piao, et al. Construction of Virtual Simulation Platform System Based on Training of Engineering Innovative Talents. Education Teaching Forum, Vol. 39, pp. 389–390, 2020.
6. L. C. Huang, X. T. Qi, et al. Exploration on all-round training model for college students in new era: Carrier function of teaching project based on virtual simulation experiment. Experimental Technology and Management, Vol. 37, pp.1–4, 2020.
7. Y. Y. Li , L. P. Liu, Q. Z. Chen, et al. Exploration and Practice of Blended Teaching Model Based on Virtual Simulation: Taking the Experiment of Coating Chemistry and Technology as an Example. Education Teaching Forum, Vol. 33, pp. 213–215, 2020.