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Construction and Innovative Application of "AI+ Virtual Simulation" Sailor Craft Course

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Abstract

With the development of artificial intelligence and virtual simulation technology, the traditional teaching mode of maritime practical courses has ushered in a turning point. This article focuses on exploring the construction path and application effect of "AI+virtual simulation" technology in sailor craft course. By constructing a curriculum system integrating AI intelligent teaching and virtual simulation training, and combining with teaching practice, the learning effect is compared and analyzed. The results show that the students in the experimental group scored an average of 89.9 points in the core skills tests such as knot playing and cable tying, which was significantly higher than the control group's 75.6 points, and the operation error rate was reduced by over 13%. The research shows that the integration of AI technology and virtual simulation platform not only improves the standardization and proficiency of students' skill mastery, but also enhances their learning interest and self-training frequency.

Keywords

AI teaching; Virtual simulation; Sailor craft; Curriculum design; Teaching practice.

1. Introduction

In the practical and skilled courses, artificial intelligence and virtual simulation technology have brought new opportunities for the innovation of teaching content and methods. As an important basic course for navigation majors, seaman's craft involves knots, cable operation and mooring skills, which is highly practical and experienced [1]. However, for a long time, its teaching methods were mainly demonstration by teachers and imitation by students. Due to the limitations of teaching venues, equipment resources and teaching time, students had limited practical practice opportunities and the learning effect was difficult to guarantee [2]. The new generation of students are more likely to accept digital and interactive learning methods, and the traditional "blackboard+practical operation" mode is difficult to stimulate their interest in learning, and modern ship equipment is constantly updated [3]. Although many traditional crafts still have practical value, it is difficult to restore the real scene in teaching, which leads to students' misunderstanding of skill application.

Introducing artificial intelligence and virtual simulation technology into the construction of sailor craft course has become the key path to improve teaching quality, enhance learning experience and realize teaching innovation [4]. With the help of intelligent teaching system, AI technology can provide students with personalized learning path, real-time feedback and auxiliary assessment. Virtual simulation can build a realistic operating environment, allowing students to carry out high-frequency and low-risk skills training in virtual space [5]. Focusing on "AI+virtual simulation", this article explores the construction path and innovative application of sailor craft course. By analyzing the teaching characteristics and practical difficulties of sailor craft course, combined with the current development trend of educational technology, a set of course design scheme integrating AI intelligent teaching and virtual simulation training is put forward [6]. The purpose of this article is to build a new teaching

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mode which is student-centered, technology-supported and ability-oriented, and to promote the development of seaman's craft course in an intelligent and interactive direction. With the continuous maturity of artificial intelligence and virtual simulation technology, this kind of teaching mode is expected to be popularized and applied in a wider range, which will promote navigation education to a higher level of intelligence and personalization.

2. Theoretical Basis and Technical Support

Sailor's craft course is the key component of navigation specialty, and its teaching content covers many operational skills and practical experience, which requires high teaching environment and training methods. Traditional teaching mode mainly relies on teachers' live demonstrations and students' repeated exercises, but limited by teaching resources, safety factors and training frequency, it is difficult to meet the requirements of modern navigation education for skill mastery depth and proficiency [7]. For this reason, building a new teaching system based on AI and virtual simulation technology requires both technical support and the support of specific educational theory [8].

From the perspective of educational theory, constructivism learning theory provides important support for the teaching mode of "AI+virtual simulation". This theory emphasizes that learners construct knowledge through active exploration, practice and reflection in specific situations. Sailors' craft skills learning is a highly situational and operational activity, and students need to practice repeatedly in real or simulated environment to master the skills. Virtual simulation technology brings students an immersive learning experience by building a highly restored operation scene, which helps them to deeply understand their skills in the simulation situation.

Cognitive load theory also provides theoretical basis for instructional design. This theory shows that students' cognitive resources are limited in the learning process, and teaching design should reduce external cognitive load and improve internal cognitive efficiency [9]. AI technology has obvious advantages in this respect. For example, the intelligent teaching system can dynamically adjust the teaching content and difficulty according to the students' learning progress and mastery, so as to prevent information overload; Virtual simulation system can guide students to master complex skills step by step, reduce learning difficulty and improve learning efficiency through step-by-step demonstration, error prompt and instant feedback.

From the technical support level, the application of artificial intelligence technology in teaching is becoming more and more mature. AI is not only a tool for presenting teaching content, but also plays the role of intelligent guidance, personalized learning path planning and learning effect assessment [10]. For example, the intelligent question answering system based on natural language processing provides instant learning support; Personalized recommendation system based on machine learning, which pushes suitable resources according to students' learning behavior and grades; The assessment system based on computer vision can identify and analyze the standardization of students' operation actions and give targeted feedback.

Virtual simulation technology has created a brand-new training platform for sailor craft teaching. With the help of VR/AR equipment, students can carry out skills training such as knotting, cable tying and deck operation in virtual environment, without relying on real equipment and venues, which not only reduces the teaching cost, but also improves the flexibility and safety of training. More importantly, the virtual simulation system can record students' operation process and generate detailed operation data, which is convenient for teachers' teaching assessment and personalized guidance.

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3. "AI+ Virtual Simulation" Sailor Craft Course Design

In the traditional sailor craft teaching, skill teaching is highly dependent on teacher's demonstration and students' repeated practice, and limited by teaching resources, operating environment and training frequency, so teaching efficiency and learning effect are often difficult to guarantee. In order to solve these problems, this article puts forward a curriculum design scheme based on "AI+ virtual simulation" technology.

Curriculum design is based on constructivist learning theory, emphasizing situational, practical and personalized learning paths. The whole course revolves around three levels of "knowledge input-skill training-comprehensive application", which correspond to three modules: AI-assisted teaching, virtual simulation operation and intelligent assessment feedback.

In the stage of knowledge input, AI intelligent teaching system is used to explain basic knowledge and guide personalized learning. The system constructs a sailor's craft knowledge point system through knowledge map, and dynamically adjusts the teaching content according to the students' learning progress and mastery.

In the skill training stage, a virtual simulation platform is introduced to construct a highly reductive operation scene. Students can train in the virtual environment such as cable tying, knot playing and deck equipment operation through VR equipment, and the system provides real-time operation feedback to help students correct their mistakes in time.

In the stage of comprehensive application and assessment, AI system combines virtual simulation data to intelligently analyze students' learning process, generate personalized learning reports, and provide suggestions for improvement. The system can also adjust the follow-up learning content according to the students' performance, and realize the integrated teaching closed loop of "learning-practice-assessment". Table 1 lists the main modules, technical support and teaching functions of the course.

Table 1. Module Design and Technical Support of the "AI+Virtual Simulation" Nautical Skills Course

Module Name	Technical Support	Teaching Function Description
AI Intelligent Teaching Module	Knowledge Graph, Adaptive Learning Algorithms	Provides personalized learning paths, dynamically adjusts content, supports intelligent Q&A and feedback
Virtual Simulation Practice Module	Unity/Unreal Engine, VR Devices	Builds realistic operation scenarios, supports high-frequency, low-risk skill training (e.g., knot tying, mooring)
Intelligent Assessment and Feedback Module	Machine Learning, Data Analysis Algorithms	Collects operation data in real-time, analyzes skill mastery, generates personalized learning reports
Teaching Management and Collaboration Platform	Learning Management System (LMS), Cloud Data	Supports instructor management, student progress tracking, and multi-device collaborative learning

With the help of the above curriculum design, the interaction and immersion of teaching are enhanced, and students' understanding and mastery of sailor's craft skills are also enhanced. This design breaks the dependence of traditional teaching on venues and equipment, and provides a feasible path for the digital and intelligent transformation of navigation courses.

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4. Teaching Practice and Application Analysis

In order to verify the practical application effect of "AI+ virtual simulation" teaching mode in sailor craft course, two parallel classes were selected as experimental objects in a maritime university to carry out teaching practice for one semester. The experimental group adopted "AI+ virtual simulation" teaching mode, while the control group followed the traditional teaching mode. The course focuses on core skills such as knot playing, cable tying and deck operation. The teaching period is 16 weeks, with 2 class hours per week.

In the process of teaching implementation, the experimental group relies on AI intelligent teaching system and virtual simulation platform, and combines task-driven and situational teaching method to carry out hierarchical teaching. Students first complete knowledge learning and self-test in the AI system, and then conduct skills training in the virtual simulation environment, and receive real-time feedback and grading from the system. Teachers adjust the teaching rhythm and key content according to the learning data provided by the platform to achieve accurate teaching.

Table 2 shows the basic implementation of the two groups of teaching, including teaching methods, training frequency and resource use.

Table 2. Comparison of Teaching Implementation Between Experimental and Control Groups

Indicator	Experimental Group (AI+VR)	Control Group (Traditional)
Teaching Method	AI-assisted + Virtual Simulation	Instructor-led + Hands-on Practice
Weekly Practice Time (minutes)	70	30
Average Practice Times per Student (semester)	125	45
Feedback Method	System Feedback + Teacher Review	Teacher Review Only
Learning Resource Utilization Rate	>90%	<60%
Student Self-learning Engagement	High	Medium

The students in the experimental group are obviously superior to the control group in training frequency, resource utilization rate and learning initiative. Especially in the mastery of operation skills such as knot play, the students in the experimental group have significantly improved their standardization and proficiency through repeated training and instant feedback on the virtual simulation platform.

Table 3. Comparison of Skill Performance Between Experimental and Control Groups

Skill Item	Experimental Group (Avg. Score/100)	Control Group (Avg. Score/100)	Error Rate (Experimental)	Error Rate (Control)
Single Loop Knot	91.5	78.3	8.2%	21.5%
Double Loop Knot	89.7	74.6	9.8%	24.1%
Mooring Line Handling	90.2	76.4	7.9%	23.7%
Deck Equipment Operation	88.4	72.9	10.3%	27.6%
Overall Score	89.9	75.6	/	/

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In order to further analyze the teaching effect, this study also comprehensively evaluates students from the aspects of skill mastery, learning interest and operation error rate. Table 3 shows the performance comparison of the two groups of students in the key skills test.

The average score of the experimental group in each skill test is more than 14 points higher than that of the control group, and the operation error rate is significantly reduced. This shows that "AI+ virtual simulation" teaching mode has obvious advantages in improving students' skill mastery level and reducing operational errors.

After the teaching practice, it was found through questionnaire survey that the students in the experimental group were generally interested in and satisfied with the course. More than 85% of the students said that they were "more willing to practice in a virtual environment" and 78% thought that "systematic feedback would help to correct mistakes in time". These feedbacks further verify the positive role of this teaching mode in improving learning experience and teaching effect.

5. Conclusions

This article focuses on the construction and application of "AI+virtual simulation" in sailor craft course, and puts forward a set of course design scheme integrating intelligent teaching and immersion training. The research results show that the personalized teaching system based on AI can effectively help students to understand and master the basic knowledge, while the virtual simulation technology can greatly improve the frequency and quality of skill training. The class adopting the teaching mode of "AI+Virtual Simulation" scored an average of 89.9 points in the core skills tests such as knot playing and cable tying, which was much higher than the 75.6 points of the traditional teaching group, and the operation error rate was reduced by over 13%, highlighting the remarkable advantages of this mode in improving students' operational standardization and comprehensive ability.

The average operation training time of students in the experimental group is 70 minutes per week, which is much longer than that of the control group, and the average operation times per semester is 125 times, which shows that the virtual simulation platform greatly enhances the flexibility and repeatability of training. More than 85% of the students said that they prefer to practice repeatedly in virtual environment, which shows that this teaching mode has a positive effect on improving learning interest and participation.

Although the teaching mode of "AI+Virtual Simulation" presents a good application prospect, it still faces some problems such as high technology development cost, great demand for teacher training, and some students' difficulty in adapting to the virtual environment. In the future, we can further optimize the interactivity and intelligence of the teaching platform and improve teachers' ability to use new teaching tools.

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