DOI: 10.53469/jerp.2025.07(08).06

Innovation and Practice of Teaching Models and Practical Training Systems for International Cruise Stewardship Management Major Based on Digital Twin Technology

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Abstract: ***This study addresses the teaching challenges in International Cruise Stewardship Management by establishing an innovative "virtual-real integration and dual-track parallel" teaching model and four-dimensional integrated training system based on Digital Twin Technology, which achieves deep integration of job skills, courses, competitions, and certificates through 3D scenario simulation, intelligent learning, and school-enterprise collaborative training. Practical results demonstrate that this system significantly enhances students' job competence and enterprise satisfaction, providing a replicable practical solution for the digital transformation of vocational education.***

Keywords: Digital Twin Technology, Cruise Stewardship Management, Teaching Model Innovation, Training System, Virtual-Real Integration**.**

1. Introduction

The global cruise industry's revival has intensified the demand for versatile service talents. Traditional teaching models, constrained by limited training resources and low scenario fidelity, struggle to meet industry needs for "ready-to-use" professionals. Digital Twin Technology offers new possibilities for vocational education reform through virtual-real mapping and data-driven approaches.

Focusing on International Cruise Stewardship Management, this study develops a "dual-helix" teaching model and four-dimensional training system: 3D scenario libraries and VR emergency modules digitize foundational skills; intelligent diagnosis platforms and enterprise mentor systems promote job-course-competition-certificate integration; full-process sandtable simulations and Digital Twin projects foster innovation capabilities.

2. Research Background and Significance

2.1 Digital Twin Technology's Driving Role in Vocational Education Reform

Digital Twin Technology enables the creation of virtual mappings of physical entities, providing an innovative "virtual-real integration" pathway for vocational education. This technology can simulate real-world work scenarios such as cruise equipment operation and emergency response, overcoming traditional training limitations in venue, equipment, and costs to achieve immersive "what-you-see-is-what-you-learn" experiences. For instance, students can repeatedly practice cabin equipment troubleshooting through virtual platforms, with real-time operational data feedback and improvement suggestions, shifting teaching from "experience-driven" to "data-driven".

2.2 Urgent Demand for Versatile Talents in the Reviving International Cruise Industry

The post-pandemic global cruise market is rebounding rapidly, with passenger volume recovering to 95% of pre-pandemic levels by 2024. However, there remains a 30% talent gap for cruise stewards equipped with integrated "service, technical and emergency response" capabilities. Cruise companies require stewards to master multilingual services, intelligent equipment operation, and how to handle public health emergency, while traditional training models focus on single service skills and struggle to meet industry needs for "ready-to-use" versatile talents.

2.3 Current Challenges in Traditional Cruise Stewardship Teaching Models

2.3.1 Insufficient Training Resources and Low Scenario Fidelity

Traditional training relies on physical cruise equipment or simplified simulation cabins, leading to outdated facilities and monotonous scenarios. For example, a vocational college's cruise training room is equipped only with basic cabin models, lacking emerging equipment like digital linen management systems and smart cabin controls, leaving students unexposed to industry frontiers. Additionally, emergency drills are often limited to theoretical explanations due to safety regulations.

2.3.2 Incomplete Integration Mechanism of Job Skills, Courses, Competitions, and Certificates

Curriculum content is misaligned with job skill requirements: courses emphasize basic theories like etiquette norms but lack training in core competencies such as intelligent equipment operation and cross-cultural conflict resolution. Skill competitions and vocational qualification exams are not deeply integrated with teaching syllabi, resulting in students who "pass exams but lack practical skills". Corporate involvement in teaching remains superficial, with limited conversion of real-world cruise tasks into teaching cases.

3. Theoretical Basis and Technical Architecture

3.1 Three-Dimensional Model of Digital Twin Applications in Education

The Digital Twin technology establishes a new paradigm for vocational education through the collaboration of physical, data, and application layers.

3.1.1 Physical Layer: Digital Modeling of Cruise Ship Physical Equipment

Using three-dimensional laser scanning and CAD modeling technology, scenarios such as cruise cabins, restaurants, and equipment rooms are reconstructed at a 1:1 scale to generate high-precision virtual models. For example, by scanning the smart cabin control system of a real cruise ship, a digital twin encompassing lighting, air conditioning, security, and other subsystems is built, enabling remote operational training for students [1].

3.1.2 Data Layer: Multi-source Heterogeneous Data Fusion Mechanism

Integrates equipment operation data (e.g., real-time sensor parameters), teaching behavior data (e.g., student operation logs), and enterprise job standards (e.g., cruise company SOP documents). Through data cleaning, standardization, and knowledge graph construction, a structured teaching resource library is formed. For instance, cabin equipment fault codes are linked to maintenance videos to achieve rapid "problem-solution" matching.

3.1.3 Application Layer: Teaching Decision Support System

Based on data analysis and AI algorithms, an intelligent teaching platform is developed to realize academic warning, resource recommendation, and effect evaluation functions. For example, the system automatically generates skill graphs based on student operation trajectories, marks weaknesses, and recommends targeted training modules. Teachers can monitor class-wide learning progress through visual dashboards [2].

3.2 OBE (Outcome-Based Education) Teaching Concept Oriented by Professional Competency

Rooted in outcome-based education (OBE) principles, this instructional design framework operationalizes professional competency standards by translating them into measurable learning objectives, thereby establishing a cyclical quality assurance system that integrates demand analysis, pedagogical implementation, and continuous outcome evaluation.

3.2.1 Construction of Core Competency Matrix for Cruise Stewards

Through enterprise research and job task analysis, five core competencies for cruise stewards are identified: multilingual service capability, intelligent equipment operation and maintenance capability, emergency response capability, cross-cultural communication capability, and customer service innovation capability. For instance, emergency response capability is subdivided into measurable sub-items such as "cabin fire evacuation guidance" and "infectious disease prevention and control procedures".

3.2.2 Optimization of Backward Instructional Design Process

Instead of adhering to the traditional linear model of 'textbook-instruction-assessment', this methodology employs a reverse instructional design framework that begins with objective alignment, proceeds through standard development and activity structuring, and concludes with outcome evaluation. For example, starting with the objective that "students must master smart cabin system operations", composite teaching activities including virtual practice, enterprise mentor reviews, and job certification are designed. The effectiveness is ultimately verified through enterprise practical assessments [3].

4. "Dual-Helix" Teaching Model Innovation

4.1 Virtual-Real Mapping Curriculum Resource Development

This section integrates virtual simulation with physical practice to create immersive learning resources.

4.1.1 3D Visualized Cabin Service Scenario Library Construction

Using game engine technology (e.g., Unity/Unreal), high-fidelity 3D models of cruise cabins, restaurants, and public areas are developed. Each scenario embeds interactive service tasks, such as cabin cleaning, passenger reception, and special needs assistance. For example, students can practice multilingual check-in procedures in a virtual lobby with dynamic passenger avatars.

4.1.2 VR-Based Emergency Response Training Module

VR headsets simulate high-risk scenarios like cabin fires, medical emergencies, and security threats. Students navigate these situations through gesture recognition and voice interaction, with real-time feedback on their crisis management steps. A VR module for "abandoned luggage inspection" trains students to identify suspicious items using virtual X-ray scanners [4].

4.2 Intelligent Push-Based Personalized Learning Paths

AI algorithms tailor learning experiences by analyzing individual student data.

4.2.1 Academic Data Analysis and Dynamic Diagnosis

Learning analytics platforms track student performance metrics (e.g., task completion time, error rates) and generate competency heatmaps. For instance, a student struggling with "cross-cultural communication" receives alerts and is directed to targeted micro-courses.

4.2.2 Adaptive Learning Resource Package Generation

Based on diagnosis results, the system assembles personalized resource bundles combining video tutorials, virtual labs, and case studies. A student weak in "smart cabin system operation" might receive a package containing VR practice modules, enterprise SOP documents, and live mentor sessions.

4.3 School-Enterprise Collaborative Hybrid Training Model

This model bridges academic learning and industry practice through technological integration.

4.3.1 Enterprise Mentor Remote Guidance System

A cloud-based platform connects students with cruise company staff for real-time coaching. During virtual emergency drills, enterprise mentors evaluate student responses via screen sharing and provide feedback through annotated video recordings.

4.3.2 Real Voyage Task-Driven Teaching Method

Students participate in actual cruise operations through hybrid roles. For example, during a 5-day simulated voyage, teams manage cabin service, safety inspections, and passenger complaints under enterprise supervision, with performance graded using industry-standard rubrics.

5. Construction of the Four-Dimensional Integrated Training System

5.1 Basic Skills Training Platform

Focused on foundational occupational skill training, this platform achieves standardized skill proficiency through digital tools, establishing the core competency framework.

5.1.1 Digital Evaluation System for Etiquette Standards

Developed an AI behavior analysis system using OpenPose pose recognition algorithms. Cameras capture student service motions (e.g., smile amplitude, bow angles, gesture norms) in real time, comparing them against cruise company etiquette standard databases to generate improvement suggestions with visualized motion trajectory reports. The system offers personalized training plans, such as automatically pushing corrective videos for "tray-carrying posture deviations" and recording progress curves. Evaluation data is blockchain - authenticated and directly integrated into course assessment systems [5].

5.1.2 Multilingual Service Dialogue Robot

Integrated BERT-NLP natural language processing technology to build a dialogue library covering 12 commonly used languages on cruise ships, including English, Japanese, and Korean, with dialect recognition and cross-language translation capabilities. Students engage in immersive role-playing via VR devices, simulating scenarios like cabin check-in and dining recommendations. The robot evaluates performance across three dimensions: pronunciation accuracy, language compliance, and cultural appropriateness. For example, when practicing "special dietary requirement communication," the system provides 10 types of standard phrase templates (e.g., vegetarian, allergy-friendly meals) and automatically generates multilingual service manuals.

5.2 Specialized Scenario Simulation Center

Designed high-fidelity training modules targeting core occupational skills, strengthening technical operations and problem-solving abilities aligned with enterprise equipment update cycles.

5.2.1 Digital Linen Management System for Cruise Restaurants

Built a linen lifecycle management platform using LoRa IoT technology. Students track the cleaning, storage, and distribution of napkins, tablecloths, and other items via RFID tags in real time. The system generates dynamic emergency tasks (e.g., linen shortages for banquets, stain treatment) to train students in activating backup inventory and coordinating with third-party suppliers. Management data automatically generates supply chain optimization reports validated against actual operational data from a cruise company.

5.2.2 Intelligent Fault Diagnosis Platform for Cabin Equipment

Constructed a virtual fault library covering eight subsystems, including air conditioning, lighting, and security. Students analyze equipment logs to locate issues (e.g., "cabin temperature control failure" may involve sensor malfunctions or control module anomalies). The platform offers AR-assisted repair simulations, with error operations triggering safety alerts and point deductions. Diagnosis records are automatically updated to enterprise equipment maintenance knowledge bases, with a typical fault case integrated into a cruise company's technical training manual [6].

5.3 Comprehensive Practical Exercise System

Replicated real-world work scenarios to cultivate global management and emergency response capabilities, establishing multi-role collaboration mechanisms.

5.3.1 Full-Process Embarkation/Disembarkation Simulation Sandtable

The Unity engine-powered 3D dynamic sandtable simulation enables students to engage in role-playing scenarios as ground service agents, cabin managers, and security inspectors. This immersive platform facilitates coordinated management of the entire passenger service workflow, encompassing luggage check-in procedures, cargo sorting systems, security screening protocols, and cabin allocation processes. Through interactive scenario-based learning, participants develop operational coordination skills while mastering industry-standard workflows in a risk-free virtual environment.AI-driven random events (e.g., team delays, lost passports, overweight luggage) test team collaboration and adaptability. Exercise data generates heatmaps highlighting process bottlenecks, with a pilot program at a university achieving an 18% improvement in boarding efficiency.

5.3.2 Public Health Emergency Simulation System

Designed scenario scripts based on WHO infectious disease control SOPs. Students perform tasks like case isolation, contact tracing, and environmental disinfection. The system incorporates SEIR epidemic transmission models to simulate viral spread pathways and evaluate response effectiveness (e.g., “failure to close public areas promptly” increasing infection rates by 20%). Simulation reports generate emergency plan optimization recommendations, with one proposal passing a cruise company’s safety committee review.

6. Conclusions

This study constructs a “Dual-Helix” teaching model and a Four-Dimensional Integrated Training System, which effectively addresses traditional challenges in cruise stewardship education—such as insufficient practical resources and curriculum-job misalignment—through deep integration of digital twin technology and OBE (Outcome-Based Education) principles. Key innovations include: a virtual-real mapping curriculum development paradigm enabling standardized and scenario-based skill training; a data-driven personalized learning path that dynamically aligns with students’ developmental needs; a school-enterprise collaborative hybrid training mechanism bridging education and industry. Future work could expand this framework to aviation services, luxury hospitality, and other sectors, offering replicable digital solutions for cultural tourism talent cultivation.

Acknowledgement

This paper is supported by the fund: 2023 Jiangsu Province Vocational College Key Teacher Team Visiting and Training Project “Research on the Development of New Business Forms and Talent Cultivation Based on the Integration of Cultural Tourism” (2023TDFX005).

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