

Investigation into the Establishment of a Digital Practical Training Platform for Maritime Vocational Education

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Abstract:

With the comprehensive implementation of the “Outline for Building a Strong Education Nation” and the full promotion of the “Five Key Components” new infrastructure for vocational education, digital training platforms have emerged as a core impetus for improving the quality of maritime vocational education. This research systematically analyzes the diverse challenges currently encountered in the development of maritime vocational education training platforms. Guided by the theoretical framework of “demand-driven innovation - technology empowerment - system restructuring - ecosystem collaboration,” it synthesizes advanced domestic and international experiences in the construction of digital training platforms and examines exemplary practices from institutions like Jiangsu Shipping Vocational and Technical College. The research proposes a systematic approach to establishing digital training platforms for maritime vocational education in the new era, emphasizing the strengthening of integrated planning, the promotion of in - depth technological integration, the innovation of industry - education collaboration mechanisms, and the enhancement of faculty development. The results aim to provide both theoretical underpinnings and practical references for the digital transformation of maritime vocational education.

Keywords:

Maritime Vocational Education, Digital Practical Teaching Platform, Artificial Intelligence, Integration of Industry and Education, High - Quality Development

1. Introduction

The swift advancement of innovative business models, including intelligent vessels, automated terminals, and digital twin ports, has placed new demands on the cultivation of maritime technical and skilled personnel [1]. As the principal platform for training highly - skilled maritime professionals, maritime vocational education must synchronize with industrial transformation and expedite its digital transformation. The “Opinions on Deepening the Reform of Key Elements in Vocational Education Teaching” clearly stipulates “adhering to a demand - oriented approach, leveraging industry requirements to define teaching content, guide teaching direction, drive teaching reform, and promote teaching development.” It systematically promotes coordinated reforms across key teaching elements, such as

academic programs, curricula, teaching materials, faculty, and internship training, to transition vocational education from simple knowledge dissemination to comprehensive competency improvement [2].

Within the international maritime education domain, simulator technology is advancing towards heightened immersion and augmented intelligence [3]. Wärtsilä has formally introduced a new - generation ship handling simulator, which offers trainees a highly verisimilar environment for ship handling, navigation, and decision - making training [4]. The K - Sim full - task engine room simulator system delivered by Concorde Maritime to Finland's Aboa Mare Maritime College integrates advanced propulsion technologies, encompassing hybrid, dual - fuel, battery, and methanol - powered engines. This system fully adheres to the STCW Convention requirements and DNV certification standards, guaranteeing that trainees undergo practical training in line with the global shipping industry's green transition [5]. The Philippine Asia - Pacific Maritime Academy (MAAP) has established a large - scale training system that mimics real - world scenarios. It integrates state - of - the - art features such as digital twin systems, remote ship operation training, and alternative fuel education, thus transitioning crew training from mere certification to systematic enhancements in operational competence and risk management.

Domestic maritime vocational colleges have also made remarkable advancements in the development of digital training platforms, establishing distinctive practical models. Jiangsu Maritime Vocational and Technical College initiated the construction of the "Zhihai" intelligent management platform for practical teaching [6], which is based on the professional competency requirements of the shipbuilding and offshore engineering industry chain. The platform integrates multidimensional data, including student information, training projects, operational behaviors, and real - time interactions, to transform training management from experience - based to data - driven approaches. Dalian Maritime University and COSCO Shipping Group jointly established the "Yuhai Zhiqi" intelligent ship training center [7]. Using the "Xinhongzhuan" smart ship as a platform, it incorporates advanced technologies to create a comprehensive on - board training system integrating teaching, research innovation, and technical validation. This system enables simultaneous practical training for 30 students in fields such as marine electronics operation, intelligent navigation, and remote control. The completion of this platform signifies a significant leap in China's maritime vocational education training infrastructure, transitioning from land - based simulations to intelligent on - board training. Harbin Engineering University and China Shipbuilding Industry Corporation jointly developed the "Xinghai" large - scale AI model, representing an innovative exploration of AI - powered maritime education [8]. This platform integrates maritime industry knowledge with artificial intelligence, providing functions such as course learning and virtual simulation practices, and establishing a knowledge repository containing industry - specific insights, ship test data, and job analysis information.

As a key component in the reform of maritime vocational education, digital training platforms not only fulfill the core function of skills training but also serve as a vital foundation for the integration of industry and education and technological innovation. Nevertheless, the current development of such platforms in China still encounters challenges, including insufficient top - level design, low technological integration, inadequate industry - education collaboration, and weak faculty support. These challenges impede their capacity to effectively meet the requirements for cultivating maritime professionals in the new era. Therefore, a systematic exploration of the

development paths for digital training platforms is of great theoretical and practical significance for improving the quality of maritime vocational education and supporting the transformation and upgrading of the shipping industry.

2. The Present Practical Challenges Encountered in the Development of Vocational Maritime Education and Training Platforms

Presently, although China has achieved positive advancements in the development of vocational maritime education training platforms, a multitude of practical challenges persist [9], which are mainly manifested in the following four aspects.

2.1. The absence of top - level design results in unbalanced regional development.

From a macroscopic perspective, the development of vocational maritime education and training platforms is devoid of a unified planning framework and standard system. During the platform construction process, different institutions and regions operate independently, lacking an effective coordination mechanism. This situation results in both redundant resource allocation and structural waste. There are significant disparities in training facilities between coastal and inland regions, as well as between leading and ordinary institutions. Moreover, high - quality digital training resources are unevenly distributed, which considerably impedes the enhancement of the overall quality of talent cultivation.

2.2. Insufficient integration of technology; the level of intelligence necessitates enhancement.

Presently, the practical training platforms in the majority of maritime colleges predominantly depend on traditional simulators and physical equipment, with a lack of sufficient integration of advanced technologies. Although certain institutions have incorporated virtual simulation technology, its application remains fragmented, lacking a systematic technical integration method. Advanced technologies, including artificial intelligence, big data, and digital twins, are not fully utilized in these platforms, impeding the intelligent analysis of students' operations, personalized guidance, and accurate evaluation.

2.3. Inadequate industry - education cooperation and the lack of a resource - sharing mechanism

Although school-enterprise cooperation has been extensively implemented, it predominantly stays at a superficial level, such as customized talent cultivation programs and on-the-job internships. In the realm of digital training platform development, which demands long-term investment and continuous updates, there is a dearth of stable mechanisms for interest alignment and models for shared resource development between schools and enterprises. High-quality resources from enterprises, including advanced technologies, real-world data, and specialized professionals, find it difficult to be effectively integrated into institutional training systems, leading to a substantial disparity between training content and industry requirements.

2.4. Insufficient faculty support and an urgent requirement to enhance digital capabilities

The efficacy of digital training platforms is ultimately contingent upon teachers' digital teaching competencies. Nevertheless, faculty members in maritime vocational colleges generally exhibit a dearth of adequate digital literacy. Although some seasoned teachers boast extensive expertise, their proficiency in emerging technologies such as virtual simulation and AI-assisted instruction remains suboptimal; young teachers, despite their relatively higher receptivity to these technologies, frequently lack substantial practical maritime experience. This shortfall in faculty digital capabilities impedes the full exploitation of the potential of advanced training platforms.

3. The Goal Orientation and Theoretical Framework for the Establishment of a Digital Training Platform

3.1. Target Positioning

The primary objective of establishing a digital training platform for maritime vocational education in the new era is to support the digital transformation and high - quality development of the shipping industry. By utilizing next - generation information technologies, including artificial intelligence, big data, virtual reality, and digital twins, the platform intends to construct an intelligent training system featuring a combination of virtual and physical environments, data - driven strategies, personalized precision, and industry - education cooperation [10]. This endeavor aims to upgrade training from isolated skill acquisition to comprehensive vocational competence development, transform from closed - loop training models to open and shared platforms, and shift from experience - based methods to data - driven approaches.

Specifically, attention should be focused on achieving goals across the following five dimensions: Firstly, high adaptability, guaranteeing that training content is in close alignment with the requirements of the intelligent shipping industry; secondly, high efficiency, utilizing intelligent technologies to improve training effectiveness and personalization; thirdly, high balance, promoting the joint development, sharing, and optimal allocation of high - quality training resources; fourthly, high safety, ensuring training results while effectively reducing safety risks in real - world settings; fifthly, high openness, offering diversified training services to the industry and society.

3.2. Theoretical Framework

This study puts forward a four - dimensional theoretical framework [11], namely “demand - driven, technology - enabled, system - restructured, and ecosystem - coordinated”, to guide the development of digital training platforms.

The demand - driven approach acts as the logical starting point. The development of digital training platforms should be based on the actual requirements of the shipping industry for maritime professionals. It is necessary to conduct an in - depth analysis of the new competency requirements that emerging sectors such as smart ships and intelligent ports impose on crew capabilities, so as to clarify the functional positioning and content framework of the training platforms.

Technological empowerment serves as the core driving force. By thoroughly integrating technologies such as artificial intelligence (AI), VR/AR/MR, digital twins, and big data analytics into the entire training process, the training scenarios, methodologies, and evaluation mechanisms are fundamentally transformed. AI

enables the analysis of learning behaviors and provides personalized guidance; VR/AR creates immersive training environments; and digital twin technology facilitates the virtual mapping of real equipment operations and fault simulation.

System restructuring serves as the implementation pathway. The development of practical training platforms involves not only equipment upgrades but also a comprehensive renovation of training content, teaching methodologies, assessment methods, and management mechanisms. It is crucial to break through traditional course boundaries and reorganize training projects according to the “full - process, full - task” principle, establishing a progressive training system that develops from fundamental skills to comprehensive competencies.

Ecological synergy constitutes a long - term mechanism. The development and operation of digital training platforms require the collaborative participation of governments, educational institutions, enterprises, and industry organizations to establish an ecosystem featuring joint construction, resource sharing, and mutual benefit. Through innovative industry - education integration mechanisms, the deep integration and efficient allocation of educational resources and industrial resources can be realized.

4. Recommendations for the Developmental Path of a Digital Practical Training Platform for Maritime Vocational Education

4.1. Enhance integrated planning and establish a hierarchical and categorized practical training platform system

The previous fragmented development model among different institutions should be supplanted by adhering to the principle of “unified planning, hierarchical construction, classified advancement, and resource sharing” to establish a three - tiered maritime digital training platform system that integrates the national, regional, and institutional levels. At the national level, emphasis should be placed on establishing high - level, national - wide exemplary virtual simulation training bases with unified construction standards and evaluation criteria. At the regional level, shared training centers should be developed through industry - education cooperation to enhance the overall training capabilities of institutions within the region. At the institutional level, each institution should construct distinctive and differentiated professional training platforms in accordance with its educational positioning and resource advantages.

The guidelines issued by the Ministry of Education in 2026 explicitly stipulated “strengthening the development of virtual simulation training bases,” mandating the establishment of standards for the construction, management, practical project development, skills training, and assessment of internship and training bases. These standards should be promptly implemented in maritime vocational education to formulate industry - specific specifications for the development of practical training platforms.

4.2. Facilitate profound technological integration to construct an intelligent practical training ecosystem

The essence of constructing a digital training platform resides in the systematic integration and application of advanced technologies. First, an AI - enabled adaptive training system should be developed. This system can intelligently analyze the operational workflows of trainees to pinpoint skill deficiencies and provide

personalized training programs. Second, immersive VR/AR/MR training environments should be created to simulate high - risk and high - cost procedures, such as narrow - water navigation, emergency firefighting, and main engine fault diagnosis. Third, digital twin technology should be implemented to create virtual replicas of real ship equipment throughout its lifecycle, facilitating equipment disassembly training, fault simulation, and remote diagnostics. Fourth, a big data - driven training evaluation model should be established. This model can generate multi - dimensional, process - oriented competency profiles for accurate assessment and feedback on training effectiveness.

The “Zhihai” intelligent management platform for practical teaching at Jiangsu Shipping Vocational and Technical College is a significant endeavor. By integrating multi - dimensional data, including student information, training projects, operational behaviors, and real - time interactions, it lays the groundwork for data - driven training management.

4.3. Innovate the industry-education collaboration mechanisms to facilitate the co-construction and sharing of resources.

The construction of digital training platforms is marked by significant investment and rapid updates, rendering it arduous for institutions to attain sustainable development solely relying on their own resources. It is essential to innovate the industry - education collaboration mechanisms to establish a sustainable development model characterized by multi - party co - construction, shared benefits, and shared risks.

Firstly, promote the establishment of operational industrial colleges. Jiangsu Shipping Vocational and Technical College collaborated with China Merchants Shipping and other partners to jointly establish the Haishun Industrial College, propelling reforms in the talent cultivation model featuring “cross - border integration and phased progression” to realize comprehensive alignment between teaching processes and practical production scenarios. This model can be replicated and scaled during the development of digital training platforms.

Secondly, establish a collaborative development mechanism between schools and enterprises. Enterprises are encouraged to share cutting - edge technologies and real - world data with educational institutions, facilitating the joint development of virtual simulation courses and training projects. The “Yuhai Zhiqi” Training Center jointly established by Dalian Maritime University and COSCO Shipping Group serves as a valuable reference paradigm.

Thirdly, explore market - oriented operational models. While meeting teaching requirements, training platforms should be opened to the public, providing value - added services such as skills training and technical certifications to the industry, thus promoting sustainable platform development through market - driven operations.

4.4. Enhance the development of teaching staff and improve digital teaching competencies

The efficacy of digital training platforms is ultimately contingent upon teachers’ application capabilities. A systematic mechanism for enhancing teachers’ digital literacy ought to be established, concentrating on the following aspects: first, formulating a digital competency model for maritime vocational teachers, which delineates requirements for digital instructional design, new technology application,

data analysis, and AI-assisted teaching; second, carrying out regular and diversified digital skills training by organizing teachers to acquire practical experience in emerging sectors such as smart ships and digital ports, thereby enhancing their awareness and application skills of new technologies; third, establishing an incentive mechanism for digital teaching innovation to stimulate teachers to explore innovative approaches such as AI integration and virtual/augmented reality applications in practical training, leading to replicable digital teaching cases.

4.5. Enhance the evaluation system and establish a closed - loop quality assurance mechanism

The advancement of digital training platforms necessitates a scientific evaluation system to guide and guarantee its success. A comprehensive evaluation mechanism that integrates “process evaluation + outcome evaluation + value-added evaluation” should be established. Process evaluation emphasizes students’ operational standardization, problem-solving abilities, and learning engagement during practical training. Outcome evaluation assesses students’ achievement of competencies through standardized skill tests. Value-added evaluation measures the degree of individual students’ ability improvement, reflecting the differentiated value of the educational process.

Simultaneously, a quality monitoring mechanism for the practical training platform should be established to regularly collect platform usage data, student learning data, and enterprise feedback data, conduct data analysis and diagnosis, and establish a closed-loop quality system of “monitoring - feedback - improvement.” The recognition of the Virtual Simulation Training Base for Maritime Instruments at Hainan Vocational University of Science and Technology as a provincial-level exemplary base illustrates that a robust quality monitoring and evaluation mechanism can effectively drive the continuous optimization of the training platform.

5. Conclusions

The digital training platform, as the core driving force for high - quality development in maritime vocational education in the new era, is a strategic choice for systematically enhancing it. It is developed under the Ministry of Education’s policy on vocational education reform, empowered by next - generation information technologies like AI, VR, and digital twins. In the future, we should follow the “demand - driven, technology - enabled, system - restructured, and ecosystem - coordinated” framework. By strengthening integrated planning, promoting technological integration, innovating industry - education collaboration models, strengthening faculty support, and improving evaluation systems, we can systematically advance the platform’s development. Only thus can we cultivate high - caliber maritime technical professionals for the intelligent shipping era and provide talent for building a maritime and transportation powerhouse.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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