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A Study on Blended Teaching Models Based on Symbiosis Theory: Taking Shipping-Related Course Instruction as an Example

Ming Sun[1], Xitong Pan[1], Kebiao Yuan[2]*, Midakpe P. Vortia[1], Yutong Sun[3]

1.College of Transport and Communications, Shanghai Maritime University, Shanghai, 201306, China

2.School of Economics and Management, Ningbo University of Technology, Ningbo, 315211, China

3.No.2 High School of East China Normal University, Shanghai, 201203, China

Corresponding author: Kebiao Yuan, ykbjob@163.com

Abstract: This study aims to address the persistent gap between theoretical teaching and practical application, as well as the discord between online and offline learning environment in shipping-related course instruction currently. Guided by symbiosis theory, this study proposes a novel blended teaching model that integrates the strengths of both online and offline instruction. It first analyzes the characteristics of the shipping course combining strong practicality with theoretical foundation,i nternational scope with regulatory compliance, comprehensive coverage with interdisciplinary focus, and applied skills with career orientation. It also identifies prevailing “non-symbiotic” issues such as teaching-learning imbalance, imbalance between curricula and industry competency demands, and inflexible assessment methods. Subsequently, a modular and hierarchical curriculum framework was developed based on symbiosis theory. An integrated teaching system was designed where “online supports offline learning, and offline reinforcing online learning,” incorporating maritime emergencies into classroom instruction with the focus of enhancing students’ emergency response capabilities. Research findings indicate that this model promotes positive interaction and collaborative development among teaching elements, and significantly improves the quality of maritime talent cultivation. This study demonstrates that symbiosis-driven blended instruction offers a feasible and impactful approach towards advancing pedagogical reform in maritime disciplines.

Keywords: Symbiosis Theory; Blended Learning; Online-Offline Integration; Maritime Studies

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1.Introduction

With the rapid growth of global economic integration and shipping technology, China’s demand for highly qualified, innovative shipping professionals continues to grow. As the primary institutions for cultivating shipping talent, the teaching quality of higher education institutions directly impacts the implementation of the strategy to build a maritime powerhouse. This has therefore become a major concern for both industry and society. Amidst the wave of educational digital transformation, reforms in university teaching models have accelerated in recent years. Symbiosis theory which highlights the co-evolution of elements within a system, provides a new perspective for redesigning the teaching ecosystem. Through the integration of online and offline approaches, blended learning provides a viable pathway to achieve personalized and efficient

learning.

Maritime courses have distinct features, including international standardization, strong practical orientation, and interdisciplinary content. However, many existing teaching models remain teacher-centered, leading to passive learning and weak student engagement. This often separates theory from practice, fail to reflect current industry trends and also do not effectively support the interest and innovative abilities of students. This "non-symbiotic" teaching environment limits the improvement of learning outcomes and fails to align with industry expectations for adaptable, multi-skill professionals.

Therefore, to effectively enhance the quality of maritime talent cultivation, it is imperative to systematically integrate symbiosis theory with blended learning to innovate teaching models. This study aims to construct a symbiosis-oriented blended teaching framework that promotes positive interaction and synergistic development among teaching elements, providing recommendations for advancing professional teaching reform.

2.Literature Review

2.1 Application of Symbiosis Theory in Education

The concept of Symbiosis was first introduced by German biologist Anton de Bary in 1879, aiming to reveal how organisms of different species achieve mutual dependence through material connections.[1] In the 1950s and 1960s, Western sociologists expanded this concept from the natural sciences to the social sciences, forming the "symbiotic theory"[2] . In the field of education, the application of symbiosis theory to moral education, explained how human development in modern society aligned with the evolving role of education. This innovative work opened new avenues for research on the relationship between symbiosis and education [3]. Subsequently, symbiotic system was further defined as a purposeful, open, self-organizing and interconnected within the educational process [4]. Symbiosis is both a necessary and sufficient condition for achieving educational objectives, emphasizing the coexistence of individuals with nature, culture, society, and self-development [5].

From the perspective of symbiosis theory, this study analyzes the challenges in inclusive education and proposes recommendations including: constructing a symbiotic sociocultural environment, establishing professional learning communities for educators, adjusting curricula and teaching practices, and optimizing resource allocation. In recent years, symbiosis theory has been progressively refined within the field of education.

Focusing on preschool inclusive education, it was identified that the current symbiotic system faces structural contradictions, including the lack of agency among symbiotic units, asymmetrical development of symbiotic models, and lagging supportive symbiotic environments [6]. Systemic innovation is urgently needed through pathways such as fostering symbiotic awareness, reconstructing symbiotic relationship networks, and cultivating a symbiotic social ecosystem. In elementary education, researchers conducted a quasi-experimental field study involving 82 grade 5 and 6 Primary School students [7]. Their module was structured around two theoretical frameworks: the Triadic Body Theory and the Triadic Sustainability Theory. Results showed that 95.1% of students reported positive shifts in awareness, with 47.5% indicating significant improvement. Additionally, the module deepened students' multidimensional understanding of environmental scale, types, functions, urban diversity, and adaptability. In vocational education, development pathways for integrating industry and education from the perspective of symbiosis theory was actively explored, focusing on three key elements: symbiotic units, symbiotic models, and symbiotic environments [8]. Inclusive model of science education practice was also encouraged to strengthen the relationship among teachers, students, and scientific learning processes, promoting symbiotic relationships in STEM education [9].

Regarding urban-rural basic education, researchers also identified mental dilemmas encountered in the process of urban-rural educational integration from a symbiotic theory perspective, advocating for systemic approaches to conceptual innovation, environmental optimization, and institutional mechanism refinement [10].

2.2 Development of Blended Learning

With the advancement of new technologies, the integration of curriculum instruction and information technology has continued to expand. A blended learning model was developed to integrate online learning with traditional face-to-face instruction [11]. Its core objective is to combine the strengths of online self-directed learning with offline interactive seminars

to enhance student engagement and teaching effectiveness. An implementation plan for blended learning was also designed to combine the strengths of traditional classroom teaching and Massive Open Online Courses (MOOCs) [12]. Research on the factors influencing teacher-student relationships was conducted with recommendations made on implementation pathways for building these relationships harmoniously [13]. This is to enhance the effectiveness of blended teaching and learning and promote college students' achievement of academic goals. Research on three key approaches for building blended learning that seamlessly integrates online and offline components was conducted [14]. By integrating multiple survey data and relevant research, there was an analysis of the current application of blended learning and the key factors influencing student satisfaction [15]. Recommendations made to enhance course design, strengthen teacher-student interaction, optimize platform development, and improve the assessment system. These measures aimed to improve the quality of blended teaching and advance the development of higher education.

Meanwhile, research on blended learning has expanded across multiple disciplines, examining the development and implementation of a blended learning model for data journalism courses, validating the feasibility and superiority of effectively integrating online resources with offline teaching approaches [16]. The blended learning model has emerged as a pivotal breakthrough in the reform of medical education [17]. Through an in-depth analysis of its practical effectiveness in curriculum design, resource integration, and assessment feedback, the study demonstrated the significant importance in constructing a medical education system that meets the demands of the new era. In university English education, it has been argued [18] that the continued implementation and refinement of blended teaching methods effectively enhance academic journeys and meets the evolving needs of current students. In the Maritime education, two semesters of Small Private Online Course based (SPOC) blended learning practice were conducted in the International Shipping Operations course [19]. Results confirmed that this approach significantly improves teaching quality and student learning outcomes, supporting its wider application in shipping course reform.

2.3 Research on Teaching Models for Shipping-Related Courses

Maritime courses, as a core component of maritime education, directly impact the quality of maritime talent cultivation through their teaching models. The teaching approach for maritime courses has gradually evolved from traditional skill transmission to modern comprehensive competency development, and is actively exploring the deep integration of technology and education. A review [20] of an introductory course designed for general maritime education at a Chinese maritime university. The course responded to social needs and used an eight-module curriculum structure to reduce knowledge fragmentation that is caused by disconnected content delivery. Hands-on teaching methods using actual ships equipped with navigational instruments were introduced to address the shortcomings of traditional "classroom theory plus laboratory practice" approaches [21]. This facilitates the integration of theory with practice, thereby enhancing teaching effectiveness. It has also been emphasized that serious games in maritime education, offered innovative solutions to bridge the gap between theoretical knowledge and practical application, thereby improving learning performance [22]. Through qualitative analysis and stakeholder perspectives, the integration of sustainability into professional curricula, improvements in environmental performance indicators, the adoption of innovations, and students' preparedness for sustainability leadership were evaluated [23]. Nineteen interviews with educators from six Finnish universities were conducted to explore primary learning frameworks, teaching methodologies, and digital solutions, while examining the readiness of Finland's higher education system to address emerging demands in the autonomous shipping sector [24]. Further examination of new demands for maritime education in the era of intelligent shipping is also presented [25]. The study examines the challenges faced in preserving maritime culture within contemporary maritime education, and proposes implementation pathways for the preservation and innovation of maritime culture across four dimensions.

2.4 Research Review

The use of symbiosis theory in education has shifted from broad conceptual discussion to concrete small-scale teaching practice. Its research focus has expanded from philosophical and humanistic interpretation toward systematic analyses within specific contexts such as inclusive education and vocational training. This has led to a practical analytical framework centered on symbiotic units, models, and environments. Simultaneously, blended learning has evolved from the introduction

of technological platforms to the reshaping of pedagogical models. Research focus has progressed from the early attention on digital platforms towards deeper reform of teaching methods and learning processes. Learning has moved beyond simple combination of online resources and classroom teaching, placing greater emphasis on optimizing core instruction elements such as course design, teacher-student interaction, and assessment feedback. These studies provide robust theoretical foundations and valuable practical insights for the development of new teaching models. Although existing research has recognized the transformative demands of technology applications (such as serious games and SPOC models) and competency development in maritime courses, it lacks the aspect that treats online and offline instructions as organically linked teaching components that evolve and support each other. The systematic integration of symbiosis theory into the construction of blended learning for shipping courses aims to coordinate and strengthen essential educational relationships between online self-directed learning and offline interaction; theoretical learning and practical training; and educational technology with talent-development goals. This marks an important shift from "Technology-based blending" to "Ecosystem-level integration," offering both theoretical contributions and practical value. Ultimately, this approach provides a new pathway for developing high-quality, highly adaptable shipping professionals, contributing to the improved model of advanced maritime talent cultivation.

3.Analysis of Characteristics and Teaching Models in Three Shipping Courses

3.1 Characteristics of the Shipping Program

Maritime courses possess distinct characteristics that set them apart from other specialized disciplines. These characteristics directly influence the selection and effectiveness of teaching methodologies, as shown in Table 1 below.

Table 1: Key Features of Shipping Courses and Their Impact on Teaching

Course Features	Specific manifestations	Requirements for Teaching
Strong integration of practicality and theory	One must master theoretical knowledge and possess practical skills.	Theory and practice are equally emphasized.
Internationality and Normativity	Comply with international conventions and domestic regulations	Standardization and normalization of teaching content
Comprehensive and interdisciplinary	Covering multidisciplinary knowledge in management, economics, law, engineering, and more	Interdisciplinary knowledge integration capability
Applied and career-oriented	Closely aligned with industry needs	Curriculum content is updated in sync with industry developments.

3.1.1 Strong Integration of Practical and Theoretical Aspects

The shipping courses do not only require students to master solid theoretical knowledge but also demands proficient practical operational skills. The International Shipping Management course encompasses both theoretical knowledge: such as process design; decision-making methods; and optimization techniques in vessel operations management, and practical operations including cargo capacity estimation; voyage cost calculation; voyage charter party contract execution; and voyage operations scheduling. This combined learning demands require a teaching model that smoothly and tightly integrate theory with practice.

3.1.2 International and Regulatory Alignment

The shipping industry operates with highly standardized and regulated framework, shaped by both international conventions and national maritime regulations. The Maritime Safety and Policy and Marine Insurance Law must strictly adhere to international and domestic legal requirements for navigation. This strong regulatory nature requires course content to remain closely aligned with industry compliance standards, which places clear and non-negotiable requirements on teaching design and delivery.

3.1.3 Comprehensive and Interdisciplinary Knowledge structure

The curriculum for shipping studies spans multiple disciplinary fields and exhibits distinct interdisciplinary characteristics. The course Multimodal Transport Organization and Management is described as a "foundational course encompassing

multiple contents, multi-layered knowledge, diverse analytical methods, and decision-making frameworks." It is characterized by "a strong system logic, professional rigor, and comprehensive integration." The comprehensive nature of this knowledge system necessitates a teaching model capable of effectively integrating knowledge from different disciplines.

3.1.4 Practical Focus and Career Orientation

Shipping courses are closely aligned with industry demands and possess a clear career orientation. The course Port Loading and Unloading Technology and Organization, for instance, is explicitly designed to enhance students' overall competence. Its primary focus is to cultivate familiarity with ship loading and unloading management, maritime cargo handling processes, and decision-optimization techniques. This close industry connection necessitates that teaching content must keep pace with evolving industry dynamics.

3.2 Analysis of Teaching Models

Analyzing the current state of shipping course instruction from the perspective of symbiosis theory reveals a distinct "non-symbiosis phenomenon." This refers to the lack of positive interaction and mutual reinforcement among the various elements within the teaching system, specifically manifested in the following aspects as shown in Table 2 below.

Table 2: Non-symbiotic Phenomena in Maritime Education and Their Primary Manifestations

Non-symbiotic phenomenon	Main manifestations	Impact on Learning Outcomes
The imbalance between teaching and learning	Teachers control the classroom, while students passively receive instruction.	Suppressing students' initiative and creativity
Disconnect between teaching content and industry needs	Course content updates are slow and out of touch with industry realities.	Declining value of knowledge application
Evaluation methods are rigid and inflexible.	Overreliance on test scores, lack of process evaluation	fails to fully reflect students' abilities
Uneven student engagement	A minority of students take the lead, while the majority follow passively.	Overall learning outcomes show a polarized distribution.

(1) Imbalance in Teaching and Learning: In current maritime education, teachers often exert excessive control over the classroom, leaving students in a relatively passive role. This phenomenon occurs when instructors design the entire teaching process according to their own assumptions, rather than students' learning needs, resulting in limited opportunities for students' inquiry, critical discussions and independent thinking.

(2) Disconnect between teaching content and industry demands: Many maritime universities face the issue of "mismatched talent cultivation objectives with societal talent needs," This gap appears specifically in delayed curriculum content updates, repetitive teaching methods, and insufficient development of students' problem-solving, innovation and analytical thinking skills. Due to this, students are not fully prepared for the evolving needs of the modern shipping industry.

(3) Rigid and Single-Dimensional Assessment Methods: The current assessment methods for shipping courses primarily rely on a single examination-based evaluation system. This approach does not support long-term learning improvement or measure real operational abilities.

(4) Uneven Student Engagement: Uneven student participation is prevalent in shipping course instruction, where a minority of students dominate the classroom while the majority follow passively. This mirrors group cooperative learning scenarios where one dominant member often completes tasks while others withdraw into supporting roles such as note-taking. Consequently, most students lose opportunities for deep learning and hands-on practice, preventing broad skill development, and contradicting the symbiotic theory's principle of shared participation and mutual benefit.

4.Framework Development for Shipping Courses and Blended Learning Design

4.1 Framework Development for Shipping-Related Courses

The course framework serves as the foundation of blended learning and must be scientifically designed based on course objectives, instructional content, and student characteristics. Given the highly specialized and practice-oriented nature of

maritime courses, its framework must be closely aligned with the practical demands of the shipping industry and students' career development plans.

The framework for shipping-related courses should consistently prioritize student competency development, emphasizing the cultivation of professional skills, practical abilities, and innovative capabilities. Taking the course "Ship Principles and Cargo Stowage Design" as an example, its competency objectives include: mastering fundamental theories of ship structure and performance; acquiring the ability to analyze ship navigation performance; and being able to apply professional knowledge to solve practical shipping problems. To achieve these competency goals, the course framework should incorporate corresponding theoretical and practical modules, ensuring that students attain the expected competency level upon completing the course.

4.1.1 Modularization

To address the specific needs of the shipping industry, the curriculum framework should incorporate core modules with distinct industry characteristics. A modular design divides course content into several independent yet organically connected modules, each corresponding to one or more competency objectives. The following outlines the design concepts for two typical modules:

(1) Maritime Safety Management Module: Centered on the International Maritime Organization's (IMO) International Safety Management (ISM) Code as the core framework, this module integrates real-world maritime safety accident investigation reports to cultivate students' systematic safety risk management awareness and compliance operational capabilities.

(2) Green Shipping and Sustainable Development Module: Focusing on cutting-edge regulations and market mechanisms for carbon reduction in international shipping, this module explores emission reduction pathways such as low-carbon/zero-carbon fuels, energy efficiency technologies, and operational optimization. It cultivates students' sustainable development concepts and their ability to design innovative solutions.

4.1.2 Hierarchical

Following cognitive principles and the developmental stages, the content of each module is further organized into three progression learning levels as shown in Table 3 below. The "module-level" matrix structure ensures the systematic nature of knowledge points and the progressive development of competencies.

Table 3: Curriculum Content Hierarchy Design and Teaching Implementation Methods

Content Hierarchy	Core Objective	Examples of Main Content	Primary Teaching Methods
Base Layer	Build a knowledge framework and grasp fundamental concepts and principles.	The development trajectory of the shipping industry, fundamental concepts of vessel operations, principles of freight calculation, etc.	Online Self-Directed Learning (Micro-courses, Literature Reading, Online Quizzes)
Application Layer	Apply training knowledge to master core business processes and skills.	Ship voyage scheduling, route economic analysis, shipping cost accounting and control, etc.	Blended Learning (Case Studies, Simulation Exercises, Project Collaboration)
Innovation Layer	Foster critical thinking to explore cutting-edge industry developments and tackle complex challenges.	Digital Transformation Strategies for Shipping, Techno-Economic Analysis of Green Shipping Technologies, Emergency Decision-Making in Extreme Scenarios, etc.	In-person immersive engagement (specialized seminars, integrated project design, corporate expert workshops)

4.2 Blended Learning Design

Under the unified course framework, instructional design should follow the symbiotic principle of "online supporting offline, offline strengthening online." This ensures the achievement of deep integration and complementary advantages between the two teaching formats in terms of objectives, content, and activities.

Core functions of the online sessions lie in knowledge transmission and learning framework construction. It primarily provides systematic teaching concepts, stimulates learning interest, and supports personalized learning paths. Through learning activities such as micro-videos, online quizzes, interactive simulations, and asynchronous discussions, students develop early understanding while getting prepared for deeper in-person class participation. Its design hinges on concise

content and well-guided activities.

Core functions of offline sessions lie in knowledge application, deeper learning and innovation development. This focuses on strengthening advanced thinking, support complex problem solving, and apply learning real professional settings. Through face-to-face interactions such as project-based learning, group discussions, hands-on training, and in-depth debates, these sessions promote deep knowledge internalization, improve professional skills, and develop confidence and professional learning values.

The symbiotic integration of online and offline learning shows in their continuous learning cycles and feedback. Course design should form a structured learning loop of: "online preparation → offline learning → online learning expansion." Online learning provides the cognitive foundation for offline activities, while new questions and insights generated during offline interactions in turn stimulate further online exploration. This iterative cycle constitutes a continuously evolving learning loop.

4.3 Maritime Emergency Learning Integration

Due to the high-risk nature of the shipping industry, emergency response ability is a core competency for maritime professionals. Integrating emergency learning into classroom instruction extends far beyond traditional case study analysis. It should aim to establish a highly simulated, high-pressure training ground for comprehensive skill development. This approach not only bridges the significant gap between theoretical protocols and real-world responses, but it also comprehensively improves students' ability to integrate professional knowledge, make rapid decisions, collaborate effectively, and maintain psychological resilience.

4.3.1 Establish a Case Library

Authentic shipping emergency cases should be collected, reviewed and organized into a structured online case library to support both teaching and student learning.

Cases should be well-labeled using a tagging system based on incident type and response complexity. Suggested case selection criteria include, but are not limited to: grounding, oil spill, fire, extreme weather risk, and emergency coordination challenges.

A case classification structure is shown in Table 4 below.

Table 4: Classification Examples for the Shipping Emergency Teaching Case Library

Event Type	Teaching Focus	Examples of Typical Cases	Core Competency Development Goals
Collision/ Grounding	Accident Cause Chain Analysis, Emergency Decision Sequence, Damage Control and Pollution Prevention	The Ever Given Grounding Incident	Situation Assessment, Regulatory Application, Resource Coordination
Fire/Explosion	Initial Fire Control, Emergency Communication Procedures, Personnel Evacuation and Rescue	Fire Incident on the MSC Flaminia	Emergency Procedure Execution, Team Leadership and Collaboration, Psychological Resilience
Pollution leak	Pollution source control, oil spill contingency plan implementation, international and domestic cooperation mechanisms	Exxon Valdez oil spill Sangji collision and explosion incident	Familiarity with environmental regulations, selection of technical solutions, public relations awareness
Security/Piracy	Application of International Conventions, Non-Military Deterrence Strategies, Personnel Security Protection	Series of Pirate Attacks in the Gulf of Aden	Risk Assessment, Emergency Plan Activation, Cross-Cultural Crisis Communication

4.3.2 Implementation of Simulation Exercises

Based on a structured case repository, virtual simulation technology is employed to recreate maritime emergency scenarios where students are organized to conduct emergency response drills, through a continuous learning cycle. The instructional process follows a seamless simulation training loop, profoundly reflecting the symbiotic relationship between online and offline teaching.

Scenario Setup: Students work in groups on an online platform to either randomly select or are assigned a maritime

emergency case by the instructor. Within a set timeframe, they must collaborate asynchronously to develop an initial emergency response plan. This involves citing relevant international convention provisions, initiating company safety management system procedures, and allocating internal resources. The plan is then submitted to the platform. This process builds students' ability in information analysis, remote teamwork, and preliminary decision-making skills.

Role Assignment: At the offline training center, instructors incorporate dynamic variables based on common blind spots identified in online contingency plans to initiate high-fidelity simulation exercises. Students are grouped to assume roles such as captain, chief engineer, first mate, and emergency coordinator, executing response procedures under intense time pressure and incomplete information. The simulator system objectively records all operational commands and communication logs.

Debriefing and Iteration: This learning reflection is in two critical phases. First, instructors lead an immediate in-person debriefing, utilizing simulator replay data to focus on key decision points for reflection. Subsequently, the complete exercise recording, data logs, and debriefing report are uploaded onto an online platform for asynchronous, in-depth reflection. Students compare group solutions, receive expert feedback, and ultimately refine an optimized emergency response guide that surpasses the original plan through shared learning. This updated guide is then returned to the case repository, enabling iterative improvement of teaching resources and student competency growth.

4.3.3 Strengthening Industry Expert Participation

The active involvement of industry experts is crucial for ensuring the authenticity and cutting-edge nature of teaching scenarios. Their participation should extend beyond individual lectures and be systematically embedded throughout the full learning cycle.

Experts can contribute by sharing practical experience in ship safety inspections and risk assessments during online preparation stage. During the case construction phase, they can also guide the development of case libraries to ensure technical accuracy. These experts can serve as observers or stress-inducing agents to enhance scenario complexity and realism in simulation exercises while providing forward-looking critiques in debriefing sessions as their professional experience often reveal deep-seated risks and strategic blind spots that are often overlooked by both students and instructors. This continuous involvement seamlessly integrates frontline industry knowledge into the teaching process, significantly enhancing the training's relevance and added value.

5.Implementation Pathways for Blended Learning Models in Maritime Education

Based on the universal framework of symbiotic blended learning, this chapter delves into the specific context of maritime education to design an actionable implementation pathway. Our core objective is to translate the symbiotic concept from theoretical conception into pedagogical practice. Through systematic instructional design, this study aims to catalyze the co-evolution of all elements within the teaching system, ultimately enhancing the effectiveness of maritime talent cultivation. The following pathway design emerges from reflections on current pedagogical challenges and integrates observations and iterations from preliminary teaching experiments.

5.1 Transformation of Teacher-Student Roles and Building Symbiotic Relationships

In symbiosis-driven blended learning, the roles of teachers and students require profound transformation to establish a new cooperative and co-developing learning relationship. This relationship emphasizes mutual dependence and shared development between educators and learners, serving as the cornerstone for the successful implementation of blended learning approaches.

5.1.1 Teacher Role Transformation

In traditional maritime education, teachers serve as knowledge disseminators and authorities, while students remain passive recipients. Within the blended learning model grounded in this theory, the teacher's role must undergo transformation in the different aspects such as: shifting from knowledge conveyers to learning facilitators, teachers are no longer the sole source of knowledge but rather guides and inspirers of student learning.

Teachers must design appropriate learning tasks and activities based on students' learning needs and ability levels, guiding them toward self-directed learning and exploration. In the Warehousing and Distribution Management course, teachers can guide students to utilize online platforms for learning foundational knowledge of warehousing and distribution, followed by

hands-on practice in classrooms or other offline settings to help students apply theoretical knowledge to practical scenarios.

Transitioning from teaching facilitators to learning organizers, instructors must structure diverse learning activities such as group discussions, project-based research, and hands-on practice to foster student interaction and collaboration. In the International Shipping Management course, instructors can organize an "International Liner Route Planning" project where students form teams to collect data, analyze information, and design solutions through blended online and offline methods, and presenting final results and evaluation of outcomes.

Transitioning from evaluators to learning facilitators, teachers must provide personalized academic support and guidance to help students overcome learning challenges. In the Fundamentals and Applications of Intelligent Ship Technology course, instructors can offer online Q&A sessions to address student inquiries in detail. They can also guide students through ship performance testing in laboratories, helping them grasp the practical applications of intelligent ship technology.

From course developers to resource builders, educators must actively develop and construct diverse teaching resources such as instructional videos, courseware, case studies, and simulation software to provide students with rich learning materials. In the Port Loading and Unloading Processes and Organization course, instructors can develop 3D simulation software for port operations, enabling students to perform virtual operations and gain familiarity with port loading and unloading processes and their underlying principles.

5.1.2 Student Role Transformation

In the blended teaching model based on symbiosis theory, students' roles must also shift from passive recipients to active learners and participants.

From passive recipients to active explorers, students must proactively engage in the learning process, acquiring knowledge and skills through self-directed learning, online discussions, and hands-on practice. In the Shipping Economics course, students can actively gather data and information on the shipping market, analyze its development trends and influencing factors, and form their own perspectives and insights.

From individual learners to collaborative learners, students must learn to work with peers through group discussions, project-based research, and other methods to solve problems together and share learning outcomes. In the Container Transportation Management course, students can form teams to complete the "Container Terminal Operation Process Optimization" project. Through division of labor, cooperation, and mutual learning, they enhance their ability to solve real-world problems.

Transitioning from knowledge learners to skill practitioners, students must prioritize the application of knowledge and the cultivation of practical abilities, applying theoretical knowledge to solve real-world problems. In the course Port System Simulation Design, students can utilize simulators for hands-on training, simulating operations such as vessel entry and exit, cargo loading and unloading, thereby enhancing practical operational skills.

From exam takers to lifelong learners, students must embrace the concept of lifelong learning, continuously updating their knowledge and skills to adapt to the evolving shipping industry. For instance, students can utilize online platforms to stay informed about the latest developments and technological advancements in shipping, such as smart shipping and green shipping, thereby broadening their knowledge base and building long-term learning habits.

5.1.3 Building a Symbiotic Relationship Between Teachers and Students

The blended teaching model based on symbiosis theory emphasizes building a symbiotic relationship between teachers and students, promoting mutual dependence and shared development. Its characteristics are manifested as shown in Table 5.

Table 5: Core Dimensions and Implementation Approaches of the Teacher-Student Symbiotic Relationship

Symbiosis Dimension	Core Philosophy	Concrete manifestation in teaching
A democratic and equal dialogue relationship	Break the monopoly of knowledge authority and respect diverse perspectives.	In maritime law case debates, instructors participate as equal members of the discussion, collaborating with students to build a multi-layered understanding of complex legal issues.
Complementary collaborative relationship	Recognize and integrate generational strengths to achieve co-creation of resources.	Faculty contribute industry insights and business logic, while students bring digital tool application skills. Together, they collaborate to develop market analysis models or new media content.

Symbiosis Dimension	Core Philosophy	Concrete manifestation in teaching
A growth relationship where teaching and learning mutually enhance each other	View teaching as a journey of mutual growth for both teachers and students.	Teachers refine their instructional design by reflecting on student project feedback and platform learning data; students achieve significant skill advancement through personalized teacher feedback and higher-order challenges.
Emotional relationships built on mutual trust	Build emotional connections and psychological safety that transcend mere knowledge transfer.	Teachers foster an inclusive and supportive learning environment. This sense of trust empowers students to pose challenging questions, forming the emotional foundation for deep learning and innovative thinking.

5.2 Development and Optimization of Teaching Resources

Teaching resources are essential for effective implementation of blended learning models. The development and optimization of teaching resources for shipping-related courses should be closely aligned with course characteristics and student needs, making full use of information technology and industry resources to create diverse teaching materials.

5.2.1 Development of Online Teaching Resources

The development of online resources must go beyond the converting textbooks and slides into digital files. The aim is to create digital learning environments that support self-directed inquiry, scenario simulation, and cognitive interaction.

Record high-quality instructional videos covering fundamental theories, key concepts, difficult points, and case studies. These videos should employ vivid and engaging presentation methods—such as animated demonstrations, live operations, and case analysis—to enhance student interest and participation. Develop interactive digital learning materials such as animations, videos, quizzes, and discussions, enabling students interact through clicks, drags, and other operations to increase engagement and enjoyment and to improve learning outcomes. Develop virtual simulation resources that replicate real shipping scenarios and operational processes, providing students with immersive learning experiences. Establish a digital case repository to collect and organize authentic shipping industry cases, including vessel accident cases; shipping market analysis cases; and corporate management cases. The case repository should employ digital storage and management systems to enable students conveniently access and utilize cases through online platforms.

5.2.2 Optimization of Offline Teaching Resources

The optimization of offline physical teaching resources focuses on providing irreplaceable physical spaces and high-end equipment support for the transformation of online learning outcomes and the refinement of skills, thereby fostering an immersive professional environment.

There is the need to regularly upgrade laboratory equipment, teaching instruments and devices to meet the demands of practical instruction. Institutions can purchase the latest ship navigation simulators, ship engine room simulators, shipping management information systems, and other equipment to enhance the quality and effectiveness of practical teaching.

Develop practical teaching materials tailored to the needs of the shipping industry and the characteristics of students, covering practical operation procedures, precautions, assessment criteria, and other relevant content. These materials should be designed for direct skill application. Institutions should also encourage joint development of specialized textbooks by industry professionals and academic instructors to ensure both technical accuracy and professional relevance.

may also organize faculty and industry experts to jointly develop specialized textbooks for shipping courses.

There is also a keen need to improve the teaching environment to foster a conducive learning atmosphere. Schools can establish modern multimedia classrooms, discussion rooms, and learning centers to provide students with excellent spaces for study and interaction. In specialized maritime classrooms, teaching facilities such as ship models, navigational instruments, and shipping charts can be arranged to create a professional learning environment.

5.2.3 Integration and Sharing of Teaching Resources

The value of teaching resources increases when they are shared and actively used. A structured resource integration and sharing mechanism must be developed to maximize resource utilization efficiency.

Key resource pathways should include the integration of campus resources: Consolidate various internal teaching resources

such as library resources, laboratory resources, and faculty resources to support blended learning. Institutions can establish shared teaching resource platforms to integrate resources across departments and disciplines, enabling unified management and resource sharing.

There should also be the shared use of School-Enterprise resources: This includes collaborating with shipping enterprises to share teaching resources such as technical documentation, case study databases, and practical training bases to enrich instructional materials. Institutions can partner with shipping companies to access corporate resources like vessel navigation data and cargo transport records for educational and research purposes.

Inter-institutional Resource Collaboration is another method to consider: Partnering with other universities to share teaching resources such as instructional videos, specialized course contents, and virtual simulation systems enhances resource utilization efficiency. Domestic maritime universities can establish teaching resource alliances to jointly develop and share educational materials, thereby elevating the overall standard of maritime education.

5.3 Development of the Teaching Evaluation System

The teaching evaluation system is a crucial component of blended learning models serving to guide, motivate, and provide feedback for teaching activities. For shipping-related courses, the evaluation system should be closely aligned with the course characteristics and teaching objectives, employing diverse assessment methods to comprehensively evaluate students' learning outcomes and overall competencies.

5.3.1 Diversification of Evaluation Content

Evaluation criteria must align with the core objectives of shipping talent development, establishing a multidimensional assessment framework encompassing cognition, skills, behavior, and values. The framework in Table 6 below emphasizes the interconnectedness and symbiosis among the various dimensions.

Table 6: A Multi-Dimensional Evaluation Framework Based on Symbiosis Theory

Evaluation Dimensions	Core Essence	Typical Sources of Evidence	Key Evaluation Points
Cognitive knowledge	Understanding and memorization of professional concepts, principles, and regulations.	Online quizzes, periodic exams, literature review reports.	Accuracy, systematicity, and readiness for transfer in knowledge mastery.
Procedural skills	Proficiency and compliance in performing specific tasks (such as route design, and simulator operation).	Simulation operation records, practical assessment videos, project technical proposals.	Process standardization, operational proficiency, and situational adaptability.
Higher-order thinking skills	The ability to analyze, synthesize, evaluate, and resolve complex, unstructured shipping issues.	Case analysis reports, comprehensive project deliverables, and logical chains in decision-making simulations.	Problem decomposition, solution innovation, critical reflection, and metacognitive abilities.
Social Collaboration Competency	The ability to communicate, collaborate, lead, and resolve conflicts within a team.	Contribution to group projects (peer evaluations), quality of discussion forum participation, role-playing performance.	Communication effectiveness, accountability, and team collaboration efficiency.
Professional Value Identification	The tendency to internalize and practice core shipping values such as safety, environmental protection, and compliance.	Safety decision-making in simulation exercises, ethical dilemma selection, and evaluation of internship sites.	Safety awareness, professional ethics judgment, and sustainable development concepts.

5.3.2 Diversification of Evaluation Methods

Too evaluate students learning across cognitive understanding, operational skills, learning values, and professional behaviors, assessment design must combine multiple methods and include input and contributions from key stakeholders.

Process-Based Learning Assessment: This includes using online platform to automatically record learning behavior data (video viewing duration, quiz attempt frequency, forum post quality), combined with offline classroom observations (questioning frequency, group discussion contributions), to form a continuous "digital learning profile." This assessment is not for grading

purposes, but to promptly identify learning obstacles, evaluate engagement depth, and provide immediate feedback.

Performance-Based Competency Assessment: This is carried out by designing authentic or highly simulated performance tasks targeting specific skills and competencies. For example, in the "Ship Management" course, assessment might involve a comprehensive task comprising "drafting a voyage risk assessment report," "executing relevant emergency procedures in a simulator," and "delivering an oral briefing to simulated company management." Evaluation criteria employ clear rubrics that explicitly define performance characteristics for different competency levels.

Multi-stakeholder Collaborative Assessment: Incorporating teachers, peers, industry mentors, and student self-assessment as evaluation entities. Teacher evaluations emphasize academic standards and overall guidance; peer assessments effectively evaluate collaborative contributions and communication skills while fostering metacognitive development through evaluating others; industry mentor evaluations focus on practical application and professional competence; student self-assessment and reflection concentrate on goal-setting and growth awareness. Comparing and triangulating multi-source assessment data significantly enhances the objectivity and educational value of evaluations.

Differentiated Summative Assessment: Summative evaluations should avoid one-size-fits-all examinations. Instead, it should adopt a composite format comprising "core module assessments + comprehensive project evaluations + learning portfolio reviews." The learning portfolio system systematically collects students' key learning achievements over a semester or academic year, providing the most multidimensional demonstration of their developmental journey and comprehensive competencies.

5.3.3 Application of Evaluation Results

The purpose of evaluation lies in its application. Evaluation outcomes should form a closed-loop feedback system that drives collaborative evolution across three levels: students, teachers, and instructional management.

Teaching Improvement: Instructors analyze existing issues and shortcomings in teaching based on evaluation results, and promptly adjust instructional content and methods to enhance teaching quality. By analyzing students' online learning data, teachers can identify knowledge gaps and promptly adjust the focus and difficulty level of in-person instruction.

Student Development Guidance: Assessment results are used to provide personalized development guidance to help students identify their strengths and areas for improvement, and formulate academic plans and career paths. Through evaluating students' practical skills, instructors can recommend enhanced hands-on training to strengthen their practical abilities.

Teaching Quality Monitoring: Utilize evaluation outcomes as a key basis for teaching quality monitoring, conducting regular assessments and analyses to ensure continuous improvement in teaching quality. Schools can evaluate course teaching quality and effectiveness through assessments of student learning outcomes, promptly identifying and resolving issues in teaching practices.

6.Conclusion

The symbiosis-driven blended teaching model for shipping courses offers an innovative educational approach aligned with contemporary demands. Guided by symbiosis principles, the model connects the strengths of online and offline instruction, emphasizes the construction of a learning community between teachers and students, and promotes the integration of theory and practice. The model provides a new pathway to address current challenges in shipping education, including the gap between theory and practice and the fragmentation between online and offline teaching. It holds significant importance for comprehensively enhancing the quality of shipping course instruction and cultivating high-caliber, versatile shipping professionals who meet industry development demands.

In the implementation process, modern blended learning unavoidably faces multiple challenges. To address these, it is essential to enhance teacher training, enrich teaching resources, innovate evaluation systems, and guide students in adapting to new learning approaches. Simultaneously, continuous modification of teaching models through experience summarization is crucial to provide stronger theoretical support and practical insights for maritime education reform.

As both digital shipping technology and higher education teaching models continue to evolve, the application of blended learning models combined with symbiotic theories offers strong potential for future expansion in maritime education.

Moving forward, this model must strengthen its synergistic integration with the shipping industry, closely track developments

in the sector and shifts in talent demands, continuously optimize teaching content, innovate instructional methods, and refine assessment systems to drive iterative upgrades in teaching approaches. Simultaneously, cross-institutional and cross-regional exchanges and collaborations should be reinforced to share high-quality teaching resources and practical experiences, thereby providing theoretical support and practical case studies for maritime education reform. It is foreseeable that, through the concerted efforts of all parties, the blended learning model grounded in symbiotic integration theory will emerge as a significant paradigm in maritime education. This model is expected to become a key approach in the maritime higher education, supporting

Innovative, highly skilled and adaptable shipping professionals while advancing high-quality maritime education development.

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