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Research on the Practical Path of Collaborative Empowerment of Generative AI for the Integration of Classroom and Simulated Training in Higher Vocational Maritime English

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Abstract: Against the backdrop of educational digital transformation and shipping industrial upgrading, the STCW Convention puts forward clear practical teaching requirements for maritime English in higher vocational colleges. At present, there exists a prominent disconnect between classroom theory and simulated training in maritime vocational colleges, accompanied by insufficient oral practice channels, unworkable tiered teaching and rigid summative tests. Existing researches only apply generative AI to scattered teaching links without constructing a whole-process linkage system based on frontline teaching reality. Taking three maritime vocational colleges with different school-running orientations in Jiangsu Province as research cases, this study adopts questionnaires, semi-structured interviews and classroom observations to carry out a multi-case qualitative research, analyzing the practical dilemmas and internal causes of the integration of "classroom-simulated training" in higher vocational maritime English. Based on the analytical framework of OBE, situated learning and distributed agency, this study proposes a four-stage closed-loop improvement path with the collaboration of DeepSeek and Doubao, together with a full-process risk control mechanism and supporting measures. This study provides practical references for the teaching reform of maritime ESP courses.

Keywords: Generative Artificial Intelligence; Higher Vocational Maritime English; Integration of Classroom and Simulated Training; Dual-Model Collaboration.

1. Introduction

1.1. Research Background

The Outline for Building a Powerful Country through Education (2024-2035) clarifies that artificial intelligence should be adopted to shore up practical teaching weaknesses in vocational colleges. Jiangsu Province has rolled out supporting action plans for vocational-education quality improvement, which also require shipping-related curricula to restructure teaching content aligned with seafarers' real-world communicative posts[1]. As a core maritime English for Specific Purposes (ESP), maritime English aims to cultivate students' practical communicative competence for vessel-related foreign-affair scenarios including VTS communication, port clearance and maritime emergency response. Long-term teaching visits and regional institutional investigations reveal a structural "disconnect between classroom instruction and training" widely existing in domestic maritime higher-vocational colleges. Traditional teaching focuses on one-way explanation of maritime texts and vocabulary. Restricted by site conditions, shortage of simulated foreign-language practitioners and limited class hours, offline training can hardly deliver regular differentiated oral practice[2].

Currently, teachers merely deploy single general large-language models for after-class error correction. There is a notable research gap regarding full-chain teaching design covering differentiated preview, in-class situational drills and long-term after-class training supported by dual models, as well as relevant studies with complete teaching frameworks and standardized risk management. Given the practical industry-driven teaching demands and gaps in existing literature, this paper sorts out common regional teaching pain points via questionnaires distributed across multiple colleges, interviews with serving ship masters and classroom observations. Three classic educational theories are integrated to build an integrated teaching analytical framework. This paper mainly designs a four-phase closed-loop practical teaching path, identifies implementation barriers and puts forward long-term supporting measures, so as to deliver a practical digital-reform scheme for maritime higher-vocational English adapted to front-line teaching realities.

1.2. Domestic and International Research Status and Core Controversies

Overseas maritime colleges have developed AI-enabled online oral-training platforms for seafarers at an early stage to conduct maritime English training via simulated interaction. Nevertheless, they have not designed differentiated teaching systems catering to mixed-ability student groups recruited from general high schools and secondary vocational schools in China[3]. Within second-language acquisition research, Godwin-Jones proposed that human-machine multi-agent collaboration can expand language-practice channels based on distributed agency theory[4]. However, his research excludes professional calibration from industry-based ship masters and lacks a closed-loop framework integrating classroom teaching and practical training. Mohamed[5] and Hockley[6] respectively addressed two major risks: distortion of AI-generated maritime teaching materials and digital-literacy stratification divide. Yet they only proposed isolated text-constraint solutions instead of constructing full-process balancing mechanisms spanning both classroom and training sessions.

Domestic studies fall into three categories. First, AIGC-assisted teaching at discrete points, which is only applied to English writing and vocabulary instruction without linking to post-oriented practical training[7]. Second, traditional blended teaching reforms for maritime English, which adopt short-video-supported offline role-play but lack intelligent differentiation and dynamic scenario generation powered by large models[8-9]. Third, research on risk management for AI-assisted teaching, which merely sets rules for text generation without full-process auditing mechanisms for classroom and training activities[10].

Literature review identifies three unresolved core controversies in academia. First, division of rights and responsibilities for human-AI collaboration: overseas studies only define the dual "teacher-AI" relationship while ignoring the collaborative educational value of industry-based ship masters. Second, paths for integrating classroom instruction and practical training: existing reforms fall into two opposing approaches: pure offline role-play versus pure AI-supported online practice. No bidirectional-loop framework combining "classroom input + AI-supported virtual-physical training output + reverse data iteration" has been established. Third, post-oriented evaluation systems: existing assessment modes are either pure summative written examinations or isolated oral tests, neither incorporating grading dimensions from shipping enterprises for seafarer posts. Current literature only addresses partial practical problems. Systematic theoretical gaps remain in four-agent distributed-collaboration mechanisms, bidirectional integration of classroom and training activities, and three-dimensional maritime evaluation. Moreover, qualitative case analyses based on classroom observations in multiple maritime colleges and perspectives from industry ship masters are insufficient, with limited discussion on real-world implementation obstacles. These create room for innovation for this study.

2. Practical Dilemmas and Root Causes of the Classroom-Training Disjunction in Higher-Vocational Maritime English

To improve external validity and avoid sample bias from a single institution, mixed-method investigations were conducted in three maritime higher-vocational colleges in Jiangsu Province with differentiated positioning: Sample A (comprehensive maritime higher-vocational college focusing on ocean-going talent cultivation), Sample B (inland-water shipping junior college), Sample C (local maritime vocational college). In total, 186 questionnaires were distributed among teachers and students; in-depth interviews were carried out with 12 serving ship masters (6 for inland waterways, 6 for ocean-going vessels); cross-institutional classroom observations covering 24 class hours were completed. Core pain points and underlying causes are summarized based on empirical data.

2.1. Core Practical Pain Points

Consistent cross-college findings indicate three prevalent problems reported by interviewed teachers: disconnection between classroom content and training tasks, obstacles in differentiated-training implementation, and shortage of oral-interaction carriers, with institution-specific nuances. Sample B (inland-water college) lacks training materials for ocean-going emergency scenarios. Sample C faces prominent resistance to differentiated teaching due to wide gaps in students' prior academic foundations. Although Sample A is equipped with online platforms, it only adopts a single AI tool rather than dual-model collaboration for text and oral-language processing. Four major deficiencies are generalized as follows.

Structural breakdown of teaching chains. Knowledge points delivered in class are misaligned with concurrent training scenarios, and training materials are updated sluggishly. Most interviewed teachers stated that "students receive theoretical instruction without matching practical scenarios and cannot convert knowledge into communicative competence immediately after class", resulting in a complete rupture between theoretical input and practical-training output[11]. One ocean-going master commented in the interview: "Many textbook dialogues adopt standardized written expressions, while real-world maritime emergency communication on board is far more concise. There exists a gap between classroom teaching and authentic shipboard communication scenarios."

Shortage of differentiated virtual-physical interaction carriers. Off-campus training rooms only provide static simplified vessel settings, lacking dynamic full-English interactive environments such as VTS communication and maritime-collision response. Uniform training tasks fail to accommodate mixed-ability students from secondary vocational schools and under-performing general high-school backgrounds, triggering notable students' anxiety toward oral practice. Classroom observations reveal that most teaching sessions focus on vocabulary and text explanation; training activities are limited to simple role-play without dynamic emergency scenarios.

Detached evaluation criteria for classroom and training sessions. Classroom assessment mainly relies on unit closed-book written examinations. Training performance is manually scored by teachers without counting toward formative grades. Consequently, students prioritize rote memorization of theoretical knowledge over real-scene oral practice. There are no unified quantitative assessment standards for implicit post-related competencies such as seafarers' emergency communication at sea[12].

Absence of digital collaborative tools and standardized risk management. Most teachers only deploy one general large-language model for homework marking, incapable of synchronously conducting pre-class differentiated diagnosis, dynamic-scenario generation and training-data aggregation. Risks including AI-generated-content distortion, digital-literacy divide and students' excessive AI dependency permeate the whole teaching process, without standardized governance solutions[7,10].

2.2. Analysis of Underlying Causes

Based on questionnaire statistics, interview transcripts and classroom observations, root causes for the classroom-training disjunction are summarized into four dimensions.

Institutional dimension: biased orientation of curriculum assessment systems. Summative written examinations dominate assessment, while training performance accounts for low weight. Training teaching tends to be marginalized, and both teachers and students prioritize theoretical knowledge over practical training.

Resource constraints: high costs for constructing real-scene training environments and insufficient supply of online oral-interaction resources. Wide disparities in students' prior academic foundations cannot be addressed by existing teaching carriers, which fail to satisfy differentiated training demands.

Insufficient multi-agent collaboration: English teachers are proficient in language pedagogy yet lack hands-on STCW-aligned post-experience and limited awareness of authentic maritime communicative scenarios. Ship masters possess rich industry expertise but seldom participate in instructional design on a regular basis, creating misalignment between teaching objectives and post-oriented standards.

Constraints on teachers' digital-teaching competence: teachers can operate general-purpose AI tools for basic teaching tasks, but lack systematic instructional-design capabilities for dual-model collaboration, secondary auditing of AI-generated materials and teaching-risk management. Their digital-teaching applications remain fragmented.

3. Analytical Framework and Agent Division for Generative-AI-Empowered Classroom-Training Integration

3.1. Coupled Analytical Framework Built on Three Foundational Theories

This study integrates Outcomes-Based Education (OBE), situated-learning theory and distributed-agency theory to construct a three-tier top-down supporting system: target anchoring-learning carriers-multi-agent division of labor. It interprets practical dilemmas identified in investigations and provides theoretical underpinnings for improvement-path design.

Tier 1 (Top-level target anchoring: Outcomes-Based Education Theory). OBE reversely derives all teaching and training activities from post-competence outcomes, which perfectly matches STCW-set competency standards for seafarers. Traditional maritime English teaching starts with textbook knowledge points, leading to disjointed objectives for classroom and training sessions. By contrast, OBE takes core communicative competencies such as VTS communication and maritime emergency response as ultimate learning outcomes. It unifies pre-class differentiated materials, in-class micro-scenario drills, after-class differentiated training and three-dimensional terminal assessment, addressing target disjunction between classroom and training from top-level design.

Tier 2 (Middle-level learning carrier: Situated-Learning Theory). Situated-learning theory holds that linguistic competence originates from interaction within authentic social-practice contexts. Text-based learning decoupled from real-world posts only accumulates static vocabulary instead of hands-on vessel-operational expressive competence. Given the monotonous and slowly-updated scenarios in offline training rooms, dual AI models can generate batches of dynamic maritime interactive tasks and build intermediate carriers bridging classroom theories and post-oriented practices. This theory explains the cognitive mechanism behind "differentiated virtual-physical training" as a core learning carrier, verifying that practical training serves as an indispensable transmission link connecting AI tools and students' post-oriented competence.

Tier 3 (Bottom-level logic for agent division: Distributed-Agency Theory). Distributed-agency theory breaks the stereotype of teachers as the sole educational agent, advocating that educational responsibilities should be distributed across all intelligent and human participants[4]. Subject to strong industry compliance requirements, maritime teaching involves four agents: DeepSeek (maritime-text intelligent agent), Doubao (oral-interaction intelligent agent), full-time English teachers (pedagogical-guidance human agent), and shipping-industry ship masters (STCW-standard calibration agent). The collaborative logic works as follows: OBE anchors over-arching seafarer-post objectives; situated-learning theory identifies situational training as core learning carriers; distributed-agency theory assigns differentiated educational responsibilities to four agents to jointly sustain the closed-loop operation of classroom-training integration.

3.2. Differentiated Functional Division of Two Generative-AI Large Models

Based on the above analytical framework and identified teaching pain points, differentiated responsibilities for the two generative-AI models are defined to support the integrated improvement path.

DeepSeek (maritime-text large model): Verification of STCW professional terminology and vessel-communication protocols; batch generation of standardized training scripts; calculation of differentiation thresholds (60-point & 80-point benchmarks); marking of maritime English documents; output of class-level shared-learning-condition diagnostic reports. It addresses non-standard teaching materials and cumbersome learning-condition statistics.

Doubao (interactive-oral large model): Pre-class listening-and-speech proficiency assessment; real-time voice simulation of VTS operators, foreign ship masters and port officials; delivery of differentiated graded oral-practice tasks; real-time pronunciation correction and personal error-archive preservation. It mitigates shortages of oral-training resources and obstacles for differentiated oral practice.

3.3. Functional Definition of Human-Based Collaborative Agents

Drawing on distributed-agency theory, core responsibilities for two human agents are clarified. Teachers oversee overall instructional design, conduct preliminary auditing of all AI-generated teaching materials, and control teaching difficulty and linguistic standardization. Ship masters from shipping enterprises perform final-instance verification of maritime scenario dialogues from authentic ocean-going post perspectives and calibrate post-oriented communicative standards. Jointly, the two human agents mitigate risks of AI-generated maritime-material distortion and compensate for teachers' insufficient industry-oriented insights.

4. Four-phase Integrated Improvement Path Supported by Dual-model Collaboration

Derived from multi-case-study-identified practical dilemmas and the three-theory analytical framework, this paper proposes a four-phase integrated improvement path empowered by dual-AI collaboration. Interconnected and cyclically interactive, each phase is equipped with complete differentiation design, dual-source material auditing, monthly iteration and full-process risk-control rules. Practically oriented toward front-line teaching, it can serve as a reference scheme for maritime higher-vocational maritime-English teaching reform.

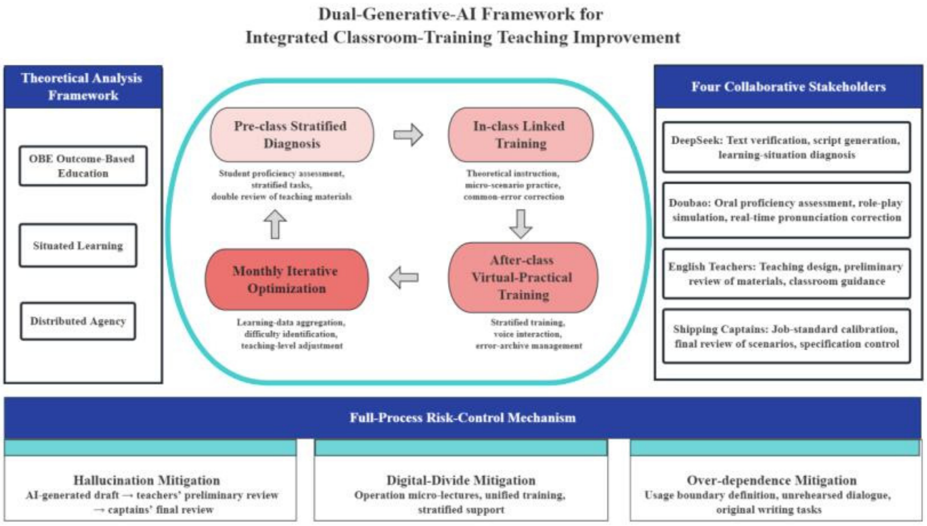

Figure 1. Framework Diagram for the Dual-generative-AI-supported Classroom-Training-Integration Improvement Path

Note: Built upon the integration of OBE, situated-learning theory and distributed-agency theory, this framework consists of four closed-loop modules: pre-class differentiated diagnosis, in-class coupled training, after-class virtual-physical practice and monthly iteration. It explicitly illustrates distributed responsibilities for DeepSeek, Doubao, teachers and ship masters. Full-process triple risk-control links are embedded at the bottom. Bidirectional data circulation between classroom and training sessions is visualized to demonstrate the operational logic of the integrated improvement path.

4.1. Phase 1: Pre-class AI-supported Differentiated Diagnosis and Dual-audit of Standardized Teaching Materials

One week prior to each unit, Doubao distributes unified listening-and-speaking comprehensive assessments to collect learning-condition data, which are imported into DeepSeek. Students are classified into three tiers: foundational, intermediate and advanced according to 60-point and 80-point thresholds. The system automatically generates supporting lecture notes and training scripts targeting vessel-operation, port-related and emergency-response knowledge points for the current unit. All materials receive preliminary review of linguistic difficulty by English teachers and subsequent verification of maritime workflows and STCW-aligned expressions by ocean-going ship masters. After dual auditing, preview assignments and online-training entrances are released synchronously. Classroom and training content are unified from the source to eliminate misalignment in teaching progress and materials.

4.2. Phase 2: Synchronized Integration of Theoretical Instruction and Micro-scenario Drills in Class

The 45-minute class is divided into three teaching segments. The first 20 minutes are allocated to systematic instruction of maritime vocabulary and vessel-communication sentence patterns. During the subsequent 15 minutes, pre-audited dialogue scripts are projected for group-based AI-facilitated situational practice, and shared oral-language errors of the whole class are corrected on-site. Finally, differentiated after-class online-training assignments are distributed according to differentiated learning profiles. Theoretical knowledge is paired with real-scene communicative practice in class to eliminate time lags between knowledge acquisition and practical application.

4.3. Phase 3: After-class All-weather Differentiated Virtual-Physical Training

Students access the Doubao training platform free from constraints of time and venue. Three tiers of tasks strictly correspond to in-class teaching content. - Foundational tier (score < 60): daily vessel-related short-sentence repetition and vocabulary-oriented AI-powered sentence-by-sentence pronunciation correction. - Intermediate tier (60 ≤ score ≤ 79): standardized scenario-based interaction covering port customs clearance and vessel watch-keeping. - Advanced tier (score ≥ 80): high-difficulty full-English emergency-response simulation for maritime-collision accidents and maritime disputes.

All training audio recordings and error labels are automatically synchronized to DeepSeek to generate personal training-growth archives, providing precise learning-condition evidence for monthly teaching adjustments.

4.4. Phase 4: Three-dimensional Weighted Assessment and Monthly Data-driven Iteration

Integrated composite assessment rules. Final grades consist of 50 % formative assessment and 50 % final written examination. Formative scores are weighted as follows: 40 % quantified AI-training performance, 35 % in-class evaluation by teachers, and 25 % post-competency rating from ship masters. The three-dimensional assessment scale covers maritime written proficiency, oral emergency-response competence and seafarer professional literacy. It enables objective quantification of implicit post-oriented competencies such as maritime emergency-handling capacity and makes up for defects of single written-examination assessment.

Monthly learning-condition iteration mechanism. Every month, DeepSeek aggregates full-volume data of in-class and online-training performance of the whole class to identify shared challenging maritime scenarios. Teachers dynamically adjust teaching emphases and training difficulty for the next month. A data-driven long-term teaching-optimization mode is realized to dynamically adapt teaching content to industry post-demands.

4.5. Full-process Triple Supporting Risk-control Rules

1) Mitigate AI hallucinations: all lecture notes and training scripts follow the workflow: "AI-drafted version → preliminary review by teachers → final verification by ship masters", so as to eliminate deviations in STCW regulations and vessel-communication expressions [10].

2) Mitigate digital-literacy divide: each unit is supplemented with 5-to-10-minute micro-lectures for digital-operation tutorials, standardizing dual-model training-operation procedures and narrowing gaps in students' tool-operating capabilities [13].

3) Mitigate students' AI over-dependency: clarify usage boundaries for AI in training; increase assessment weight for impromptu situational dialogues and original maritime-document writing; compel students to independently organize maritime-communication utterances and prevent loss of autonomous expressive competence caused by over-reliance on AI tools.

5. Analysis of Practical Implementation Barriers for the AI-empowered Classroom-Training-Integration Model

Based on multi-college case-study data and front-line teaching realities, this section identifies potential obstacles in popularizing the dual-AI-collaboration model. Idealization bias of the proposed scheme is reflected upon to enhance reflexivity and practicality of this research and provide references for subsequent optimization and implementation.

5.1. Real-world Barriers for School-enterprise Collaboration

Material auditing and teaching-research activities undertaken by ship masters demand substantial time and energy. Nevertheless, most colleges lack incentive mechanisms and reasonable time-compensation schemes for ship masters' teaching participation, hindering regular involvement. Furthermore, cooperation depth between shipping enterprises and colleges is limited. Some enterprises attach insufficient importance to maritime-English teaching for seafarers, threatening the sustainability of school-enterprise collaborative education. This constitutes one of the core practical barriers for model implementation.

5.2. Constraints on Technical-platform Integration

Interfacing campus smart-teaching systems with large-language models including DeepSeek and Doubao requires professional technical support. Some higher-vocational colleges have weak technical teams and cannot realize seamless data connection and automatic data aggregation. If a compromise semi-manual data-export solution is adopted, teachers' workload will increase and teaching efficiency will decline. Technical constraints may impede regular implementation of the model.

5.3. Constraints on Teachers' Digital-teaching Competence

Dual-AI-collaborative teaching raises higher requirements for teachers' digital literacy and instructional-design capabilities. Teachers are expected to master large-model operation, prompt-engineering design, secondary auditing of AI-generated materials and teaching-risk management. Investigations reveal that most teachers can only operate general-purpose AI tools at a basic level and lack systematic instructional-design capabilities for human-AI collaboration. Targeted special training is required to adapt to the new-model requirements.

5.4. Practical Contradictions on the Student Side

Noticeable disparities exist among students in digital literacy. Some under-performing students lack proficiency in AI-tool operation and cannot fully leverage online-training resources for competence improvement. Meanwhile, some students tend to over-depend on AI tools and lack initiative for independent thinking and expression in training, violating core objectives of practical teaching. Balancing the auxiliary role of AI tools and cultivation of students' autonomous-learning competence poses a key challenge for model implementation.

6. Long-term Supporting Countermeasures for Sustainable Implementation of the Integrated Model

Targeting the above-mentioned implementation barriers and drawing on school-enterprise-cooperation characteristics of maritime colleges, supporting countermeasures are proposed from four dimensions: teaching-research teams, school-enterprise resources, on-campus institutional construction and data platforms, to guarantee regular long-term operation of the dual-AI-collaborative integrated model.

6.1. Regular Digital-oriented Teaching-research via School-enterprise Collaboration

Hold joint thematic teaching-research sessions monthly attended by full-time maritime-English teachers and serving ship masters. Research priorities cover maritime-specific AI prompt engineering and virtual-physical-training-scenario design. Differentiated teaching materials are updated synchronously in response to the latest revisions of the STCW Convention. Incentive mechanisms with reasonable time compensation and honor recognition are established for ship masters to boost their participation willingness. Colleges organize special training for dual-model practical operation to systematically improve teachers' instructional-design capabilities for human-AI-collaborative teaching and address teachers' insufficient digital-teaching competence.

6.2. School-enterprise Co-construction of Maritime-specific AI-teaching Resources

Cooperate with partner shipping enterprises to collect first-hand authentic cases of foreign-affair communication in port, ocean-going and emergency contexts. Build a standardized differentiated maritime-prompt-engineering resource library, and iteratively update online-training tasks at foundational, intermediate and advanced tiers. All scenario-related contents are audited by serving ship masters to align with real-world communicative demands of front-line seafarers. Establish long-term resource-update mechanisms to refresh teaching materials in response to shipping-industry development and STCW revisions and guarantee timeliness and practicality of teaching content.

6.3. On-campus Institutional Construction for Integrated Teaching

Formulate special administrative rules for integrated teaching, specifying usage norms for two large-language models in classroom and online-training contexts. Explicitly incorporate virtual-physical-training performance into students' formative assessment and raise the weight of training grades. Institutionally reverse students' ingrained tendency to prioritize written examinations over real-scene oral practice. Establish workload-calculation rules for teachers, reasonably counting workload generated by AI-material auditing and online-training tutoring to boost teachers' willingness for teaching-reform participation.

6.4. Construction of Integrated Learning-condition Data-management Platform

Adopt a phased-implementation strategy to tackle technical-platform-connection constraints. In the initial phase, adopt a compromise semi-manual data-export scheme to reduce technical-connection difficulties. In the long run, leverage existing campus smart-teaching systems, cooperate with technical teams to open data-interaction interfaces for DeepSeek and Doubao. The system automatically aggregates multi-dimensional learning-condition data from in-class quizzes and online oral-training sessions, generates visual learning-condition dashboards for classes and individual students. It supports dynamic teaching-content adjustment in monthly teaching-research meetings and improves teaching-management efficiency.

7. Conclusion and Research Prospects

7.1. Core Research Conclusion

Taking three maritime higher-vocational colleges in Jiangsu Province as multi-case research subjects, this study identifies four teaching pain points: disjunction between classroom instruction and practical training, shortage of real-scene resources, obstacles for differentiated-teaching implementation, and unreasonable single summative assessment via questionnaires, semi-structured interviews and classroom observations. Underlying causes are analyzed from institutional, resource-endowment, multi-agent-collaboration and teacher-competence perspectives. Guided by OBE, situated-learning theory and distributed-agency theory, this paper interprets internal mechanisms behind the classroom-training disjunction. A four-phase closed-loop classroom-training-integration improvement path supported by dual large-model collaboration and triple risk-control mechanisms are put forward. Multiple practical implementation barriers are recognized, and targeted supporting countermeasures are proposed. The proposed teaching-reform scheme fits practical conditions of maritime higher-vocational education and offers practical references for digital-teaching reforms of maritime-English courses in peer institutions.

7.2. Research Prospects

Future research may conduct small-scale action research within a single college to iteratively optimize the proposed path and test its real-teaching effectiveness. Effective approaches for improving teachers' human-AI-collaborative teaching competence can be further explored to refine teacher-training systems. Differentiated implementation schemes should be explored for inland-water-oriented and ocean-going-oriented colleges to enhance model universality. Moreover, school-enterprise-collaboration incentive mechanisms need further refinement to break practical school-enterprise-cooperation barriers and promote regular implementation of the integrated model.

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