Academic Journal of Education
ISSN: 3080-9940 (Print), ISSN: 3080-9959 (Online) | Vol. 1, No. 2, 2026

Three-Dimensional Closed-Loop Classroom for Maritime English in Vocational Colleges Enabled by Generative AI

Xiang Huang

Jiangsu Maritime Institute, Nanjing, Jiangsu, 211170, China

Abstract: Driven by the dual forces of educational digital transformation and high-quality development of the shipping industry, generative artificial intelligence (Generative AI) provides a new technical path for innovating vocational foreign language teaching models. As a type of English for Specific Purposes (ESP), maritime English in vocational colleges is highly job-oriented and practice-intensive. At present, vocational maritime English teaching generally suffers from rigid models, difficulties in differentiated instruction, lack of practical scenarios, and fragmented teaching links. Traditional linear teaching fails to form an effective closed loop, restricting the development of students' job-related English competence. Based on generative AI, this study integrates closed-loop teaching theory and personalized learning theory, and adopts bibliometric analysis, questionnaire surveys, quasi-experimental research, and fuzzy comprehensive evaluation. Focusing on pre-class, in-class, and post-class dimensions, it deeply analyzes current shortcomings in maritime English classroom construction. It explores existing pain points in three-dimensional classrooms, details the implementation paths of AI-enabled closed-loop instruction, constructs an intelligent teaching model consisting of diagnosis, training, and consolidation layers, and establishes supporting mechanisms for technology, faculty, and evaluation. Teaching practice shows that this model effectively alleviates problems such as differentiated learning difficulties, insufficient practice, and weak connectivity, enabling cyclic data feedback and dynamic teaching optimization. This study emphasizes practicality and implementability, providing a practical model for digital reform of maritime English teaching and a reference for intelligent construction of similar specialized foreign language classrooms.

Keywords: Generative AI; Maritime English; Three-Dimensional Closed-Loop Classroom; Personalized Teaching; Vocational Education.

1. Introduction

With the advancement of China's maritime power strategy and deepening digital reform in vocational education, the shipping industry's demand for high-quality composite seafarers continues to rise. As the specialized language for shipboard communication, navigation, and port clearance, maritime English has become a core compulsory course for maritime majors. However, vocational students come from diverse backgrounds with large gaps in English proficiency, and traditional homogeneous instruction cannot meet differentiated needs. Meanwhile, practical scenario construction is costly and difficult to replicate, with weak oral training and fragmented teaching processes persisting for a long time.

Leveraging natural language generation, intelligent interaction, learning profiling, scenario simulation, real-time error correction, and data feedback, generative AI offers a low-cost, high-efficiency, scalable solution to maritime English teaching challenges. In this context, constructing an intelligent, scenario-based, closed-loop teaching model has become a key research issue in maritime English reform.

Existing domestic research on maritime English started late and mostly focuses on traditional dimensions such as curriculum content and system optimization. Research on intelligent teaching models under digital transformation remains relatively backward. Li found through bibliometric analysis that empirical studies in domestic maritime English are insufficient and technology integration is shallow, leaving broad space for digital reform [1]. Chen's survey identified structural problems such as insufficient practical resources, limited job scenario coverage, and rigid teaching models in vocational maritime English, hindering alignment with industry demands [2]. In AI-enabled foreign language education, Liu systematically summarized the value and applications of generative AI, highlighting its strengths in learning diagnosis, personalization, and scenario simulation, while noting limited industry adaptation [3]. Zhao constructed a generative AI-based differentiated model for vocational English, emphasizing the mitigation of proficiency gaps, but the model lacks full-cycle closed-loop design [4]. Regarding closed-loop and personalized learning, Zhou proposed a data-driven iterative concept but without intelligent integration [5]; Wu developed a communicative competence evaluation system for seafarers but did not address teaching models [6]. Research on situated cognition confirms that authentic scenarios significantly improve language acquisition, supporting maritime English practical design [7].

Internationally, maritime English AI research is mature, focusing on job orientation, scenario-based instruction, intelligent training, and competency standards. The International Maritime Organization (IMO) continuously updates seafarer English requirements, emphasizing oral communication, situational response, and terminology accuracy, providing a global benchmark [8]. Sutrisno developed an AI-based maritime oral training platform, showing significant improvements in fluency and accuracy via immersive simulation [9]. Purnama's TAM-based study confirmed that AI tools lower learning barriers and enhance motivation [10].

Despite these foundations, current research still lacks systematic integration of theories, holistic full-cycle models, low-cost implementable strategies, and rigorous empirical validation. Based on this, this study constructs and empirically tests a three-dimensional closed-loop classroom enabled by generative AI.

2. Current Status of Maritime English Teaching

2.1. Teaching Background

2.1.1. Shipping Industry Upgrading Raises Seafarers' Language Standards

Frequent international trade and shipping operations increase shipboard cross-border communication, port clearance, and emergency work. The IMO updates seafarer English standards, emphasizing oral proficiency, situational response, and terminology accuracy, shifting teaching from exam-oriented to competency-based [8]. Shipping companies prioritize practical ability over written tests, challenging traditional "theory-heavy, oral-light" instruction [11].

2.1.2. Educational Digitalization Drives Foreign Language Reform

The Digital Transformation Plan for Vocational Education (2022–2025) mandates AI integration, process optimization, and personalized mechanisms [12]. Maritime English must upgrade via generative AI to meet high-quality education goals. Jin et al. argued that intelligent transformation is inevitable, with generative AI addressing core pain points [13].

2.1.3. Growing Contradictions in Vocational Maritime English Classrooms

Students from general high schools, secondary vocational schools, and single-admission programs exhibit extreme proficiency gaps. Uniform pacing fails to meet diverse needs [14]. Limited training facilities, costly scenarios, fragmented pre–in–post processes hinder overall quality improvement [15].

2.2. Current Status of Three-Dimensional Classroom Construction

2.2.1. Pre-class Learning Diagnosis: Subjective Judgment and Lack of Differentiated Mechanism

At present, the pre-class teaching link for maritime English in vocational colleges is simplistic and rigid. The vast majority of teachers follow traditional lesson preparation methods, assigning only uniform preview tasks such as memorizing vocabulary and reading texts, without establishing standardized, data-driven learning assessment procedures. To accurately assess the current situation, this study conducted a questionnaire survey involving 246 maritime students and 12 professional English teachers at the sampled institution. The data reveals that only 12.4% of teachers conduct simple pre-class learning checks, and none use intelligent assessment tools for data-based diagnosis. Over 87% of students report that preview materials are identical and fail to match their individual English proficiency. Under the current model, teachers rely primarily on random classroom questioning and subjective experience to judge student performance, lacking scientific, data-driven learning analysis. Preview materials are also undifferentiated, making it difficult for less proficient students to grasp maritime terminology quickly, while advanced students lack extended learning resources. The functions of accurate pre-class diagnosis and differentiated preview are largely absent, laying hidden risks of homogeneous teaching from the outset[16].

2.2.2. In-class Practical Training: Scarcity of Scenarios and Insufficient Practical Training

In-class instruction remains teacher-centered, focusing on lectures, vocabulary explanations, and grammar analysis, with limited and dull interaction. Constrained by venue, funding, and equipment, authentic maritime scenarios such as VHF communication, customs inspection, maritime emergency response, and cargo verification cannot be replicated on-site. Oral training is limited to rote repetition and simple dialogues. In regular classes, teachers often translate texts sentence by sentence, neglecting the communicative and industry-specific nature of language. Students passively absorb theoretical knowledge, lacking real-life communication environments. While most students memorize written vocabulary, their spoken sentences are stiff, disorganized, and lacking fluency in role-plays, with obvious "mute English" and poor job readiness. Additionally, uniform training tasks fail to differentiate advanced, average, and struggling students, resulting in inadequate personalization and targeted instruction [17].

2.2.3. After-class Consolidation: Superficial Feedback and Inadequate Data Accumulation

After-class consolidation is critical for knowledge internalization, yet current maritime English homework is rigid and assessment is simplistic, failing to form effective feedback. Most teachers assign uniform written or memorization tasks, lacking oral and scenario-based practice. Feedback is delayed and vague, offering little timely guidance. Furthermore, there is no mechanism to systematically collect, analyze, or reuse learning data generated before, during, or after class. Assessments serve only grading purposes and cannot inform instructional improvements, creating a broken teaching loop.

3. In-depth Analysis of Core Problems

3.1. In-depth Analysis of Core Problems in the Three-Dimensional Classroom of Maritime English

To systematically sort out the logical relationships among the above problems, this study conducts an attribution analysis from four dimensions: teaching links, differentiated mechanisms, technology application, and evaluation systems.

3.1.1. Disconnected Three-Dimensional Teaching Links and the Lack of a Cyclic Teaching Chain

The three teaching dimensions—pre-class, in-class, and post-class—are mutually independent and disconnected. Preview content is disjointed from key classroom points, and after-class exercises have low consistency with classroom knowledge. Teaching progresses in a unidirectional, linear manner, lacking data exchange, process connection, and iterative optimization. Teachers rely on subjective experience for lesson preparation, textbooks for in-class instruction, and homework feedback for post-class review, without a scientific data-driven link between the three stages. Students preview blindly, passively listen in class, and mechanically practice after class, resulting in low knowledge retention, rapid forgetting, and the failure to form a complete learning loop. The broken feedback loop and delayed response are common pain points in vocational foreign language classrooms, which must be addressed by leveraging intelligent data to connect teaching processes[18].

3.1.2. Absence of Stratified Learning Mechanisms and Severe Student Polarization

Maritime students in vocational colleges come from diverse backgrounds with wide disparities in English proficiency. Some students have a complete grasp of grammar and oral skills, while others only master basic vocabulary, leading to significant differences in their ability to learn specialized terminology. Traditional classrooms use a uniform pace, content, and assignments, which cannot adapt to differentiated learning needs: struggling students fall behind and lose interest, while advanced students lack extended learning opportunities and are held back. As a result, class polarization worsens year by year, unbalancing the learning environment.

3.1.3. Shallow Integration of Intelligent Technology and Superficial Empowerment Effects

Although most institutions have introduced smart teaching tools (e.g., Learning Pass, Rain Classroom), their application is mostly limited to basic functions such as courseware playback, homework distribution, and attendance tracking. Core functions like learning diagnosis, scenario simulation, and personalized teaching are not fully explored. Advanced capabilities of generative AI, such as scenario generation, intelligent error correction, learner profiling, and differentiated content delivery, have not been widely implemented in maritime English teaching, making technology integration superficial. Additionally, the domestic general-purpose AI corpus for maritime majors is underdeveloped. Simulations of special scenarios like inland waterway shipping, niche ports, and extreme maritime emergencies lack precision. Some translated specialized terms and scenario dialogue scripts are awkward, grammatically incorrect, or inconsistent with industry standards, failing to meet the requirements of high-standard professional teaching.

3.1.4. Static and Monolithic Evaluation System, Lacking a Dynamic Optimization Loop

The current evaluation system has long adopted summative assessment thinking, relying primarily on final written exams and attendance records. With fixed dimensions and single indicators, it severely neglects core maritime English competencies such as oral communication, situational response, and job adaptability. The static evaluation model only reflects students' learning outcomes at a single point in time and cannot capture dynamic changes in their learning process. Furthermore, there is no data feedback mechanism in the teaching system. Large amounts of learning data generated before, during, and after class are not systematically collected, analyzed, or utilized. Evaluation results are only used for grading and cannot inform the optimization of teaching design.

Root Cause Analysis:

These problems are not caused by a single factor but are the result of overlapping institutional, faculty, resource, and student factors. At the institutional level, vocational colleges have reduced hours for specialized foreign language courses, leading to heavy teaching loads that leave teachers with insufficient time for differentiated lesson planning. At the faculty level, most maritime English teachers have strong language skills but limited practical industry experience, lacking a thorough understanding of shipboard operations. At the resource level, professional simulation training equipment is costly, making large-scale procurement unaffordable for ordinary colleges. At the student level, many lack motivation and self-discipline, leading to widespread passive learning. Under these multiple constraints, traditional classrooms naturally exhibit disconnected processes, insufficient practice, and rigid evaluation, requiring intelligent technology to address these structural contradictions.

4. Construction Strategies for a Generative AI-Enabled Three-Dimensional Closed-Loop Classroom System

4.1. Theoretical Basis and Core Principles

4.1.1. Theoretical Basis

This study is primarily based on two educational theories. First, Closed-loop Instruction Theory, which emphasizes that the teaching process should form a cyclic system of "design-implement-feedback-optimization", where output data from each round serves as input for the next round to enable continuous improvement. Second, Personalized Learning Theory, which advocates for differentiated learning paths and resources based on learners' cognitive levels, learning styles, and knowledge gaps. The learning analysis and content generation capabilities of generative AI provide the technical possibility to implement these theories in a classroom setting.

4.1.2. Core Principles

Job-Oriented Principle: Strictly design teaching content around five high-frequency job scenarios—ship navigation, port clearance, foreign-related emergencies, cargo inspection, and ship maintenance—in accordance with IMO international maritime English standards and domestic shipping company requirements.

Intelligent Differentiation Principle: Based on generative AI learning assessment technology, students are scientifically divided into three tiers: basic, intermediate, and advanced. Differentiated preview tasks, classroom training, and after-class assignments are designed for each tier.

Low-Cost Implementation Principle: All teaching is conducted using free, general-purpose generative AI tools, eliminating the need for colleges to build dedicated intelligent teaching platforms or bear high technical maintenance costs.

Data Closed-Loop Principle: Connect the three-dimensional data links of pre-class, in-class, and after-class. Collect learning data throughout the process, which automatically feeds back to the next round of teaching to enable dynamic iteration.

4.2. Overall Architecture Design of the Three-Dimensional Closed-Loop Classroom

Based on the above principles, this study constructs a three-tier integrated classroom architecture consisting of an intelligent diagnosis layer, a scenario-based training layer, and an intelligent consolidation layer, forming a complete cyclic teaching loop, as shown in Figure 1.

4.3. Refined Implementation Strategies by Dimension

4.3.1. Pre-Class Intelligent Diagnosis: Accurate Profiling and Differentiated Preview

Before class, a maritime English-specific assessment is developed using generative AI, focusing on three modules: common shipboard terminology, basic port sentences, and oral pronunciation standards. The test is kept under 10 minutes to fit the preview rhythm. The AI automatically calculates accuracy rates, identifies error-prone vocabulary, pronunciation deviations, and weak points, generating visual individual learner profiles. The system automatically stratifies students based on the results:

Basic Tier: Focus on vocabulary memorization and simple sentence repetition.

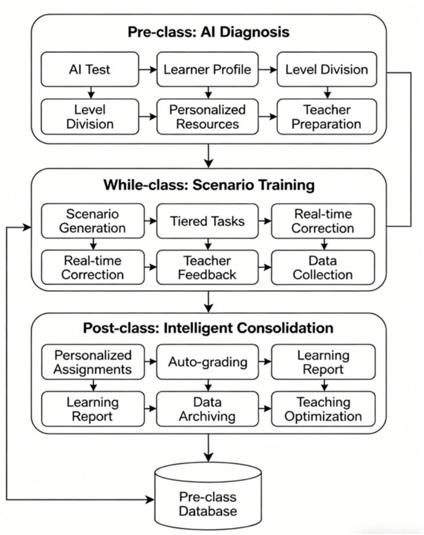

Figure 1. Generative AI-Enabled Three-Dimensional Closed-Loop Maritime English Classroom Model (Note: The pre-class, in-class, and after-class stages form a closed loop through data flow. Post-class learning data is fed back to the pre-class diagnosis database to support dynamic adjustments in the next round of teaching.)

Intermediate Tier: Focus on memorizing templates for common scenario dialogues.

Advanced Tier: Focus on practicing emergency response sentences for maritime incidents. Teachers use class-level summary reports to identify common weaknesses and adjust lesson focus for targeted teaching.

4.3.2. In-Class Scenario-Based Training: Scenario Replication and Differentiated Drills

During class, generative AI replicates five authentic maritime work scenarios: VHF ship communication, customs clearance procedures, foreign-related crew communication, on-board equipment fault reporting, and bad weather navigation communication, covering high-frequency work situations. Teachers assign tiered tasks:

Basic Tier: Complete AI-led repetition drills to correct pronunciation, standardize intonation, and memorize basic vocabulary.

Intermediate Tier: Conduct paired role-plays, strictly following industry communication protocols and mastering job communication logic.

Advanced Tier: Engage in unscripted emergency dialogues simulating maritime accidents, equipment failures, and bad weather conditions to enhance on-the-spot response capabilities. The AI identifies grammatical errors, terminology misuse, and pronunciation deviations in real time with pop-up corrections. Teachers provide a second round of human feedback, combining professional etiquette, communication logic, and industry standards to ensure both linguistic accuracy and professional appropriateness.

4.3.3. Post-Class Intelligent Consolidation: Personalized Review and Data Feedback

After class, the AI extracts in-class and pre-class assessment data, combining student tiers to generate personalized consolidation tasks covering four types of exercises: professional vocabulary review, scenario dialogue writing, oral recording retelling, and error correction drills. The system automatically grades written assignments and evaluates oral tasks using speech recognition technology, marking pronunciation flaws and sentence structure issues to generate easy-to-understand individual reports. All learning data is automatically archived and fed back to the pre-class diagnosis database, providing objective data support for the next round of tiering, task design, and lesson focus adjustments. The teaching process forms a complete intelligent closed loop.

4.4. Long-Term Operational Support System

To ensure the stable implementation of the three-dimensional closed-loop classroom and prevent intelligent teaching from becoming superficial, this study establishes a long-term support system from three dimensions: technology iteration, faculty development, and evaluation reform.

4.4.1. Technical Support: Optimizing the Maritime English Corpus

To address the limitations of general-purpose AI in maritime terminology, teachers collaborate with frontline seafarers and corporate trainers to build a dedicated maritime corpus. Focusing on inland waterway shipping, river-sea combined transport, and domestic port operations, high-frequency local dialogue phrases are added, and expressions inconsistent with Chinese shipping norms are corrected. For extreme emergency scenarios such as maritime search and rescue, ship collisions, and equipment failures, dialogue logic, professional terminology, and communication tone are manually optimized to improve scenario realism. A dynamic update mechanism is also established to continuously iterate the database based on quarterly shipping regulations and industry terminology changes.

4.4.2. Faculty Support: Building an Intelligent Teaching Team

Colleges must establish regular AI teaching training mechanisms, offering specialized training in prompt engineering, intelligent script generation, learning data analysis, and oral evaluation. Teachers are guided to restructure their teaching mindsets, shifting from traditional lecturing to focusing on instructional design, data analysis, and ability coaching. Simultaneously, efforts are made to develop "dual-qualified" teachers by arranging regular rotations in shipping companies to familiarize them with shipboard operations and port communication protocols, enhancing their industry knowledge.

4.4.3. Evaluation Support: Establishing a Multi-Dimensional Dynamic Evaluation System

Using fuzzy comprehensive evaluation, a three-dimensional evaluation system of "process dimension + competence dimension + industry dimension" is constructed, breaking the single-score evaluation model. The weight distribution for each dimension is shown in Table 1.

4.5. Teaching Effectiveness Analysis

To accurately measure the effectiveness of the three-dimensional closed-loop classroom, a rigorous controlled experiment was designed. Two parallel classes of the same grade, taught by the same teacher, were selected, controlling for irrelevant variables such as age, student background, and baseline proficiency to ensure reliable data. The experimental class (n=48) received generative AI-enabled three-dimensional closed-loop teaching, while the control class (n=46) continued with traditional lectures for one full semester.

Table 1. Weight Distribution of the Multi-Dimensional Dynamic Evaluation System

Evaluation Dimension	Evaluation Index	Weight (%)
Process Dimension	Pre-class Preview	15
	Classroom Interaction	25
	After-class Homework	20
Competence Dimension	Oral English Training	25
Industry Dimension	Industry Adaptability	15
Total		100

(Note: The new "Industry Adaptability" index invites enterprise seafarers to participate in oral assessments, evaluating students' terminology standardization, communication fluency, and professional etiquette from an industry perspective. All evaluation data is archived to form individual growth records.)

Final assessment data showed:

Average score: 84.6 (experimental) vs. 77.2 (control), a difference of 7.4 points ($t=4.21$, $p<0.01$).

Oral fluency pass rate (via simulated maritime tests): 86.5% (experimental) vs. 62.3% (control), an absolute increase of 24.2 percentage points.

Professional terminology error rate (analyzed from classroom dialogue): 12.7% (experimental) vs. 39.0% (control), a relative decrease of 67.4%.

Further behavioral data indicated significant improvements in the experimental class across all metrics: preview completion rate (91.7% vs. 66.1%), in-class participation rate (78.5% vs. 37.3%), and oral task submission rate (96.2% vs. 42.8%). Employer feedback showed that students from the experimental class took an average of three weeks less time to adapt to their roles after hiring, with significantly higher proficiency in daily shipboard communication and foreign-related procedures than their peers in the control class.

In summary, the generative AI-enabled three-dimensional closed-loop classroom offers significant advantages in teaching efficiency, educational outcomes, and industry adaptability.

5. Conclusion

5.1. Research Findings

This study addresses the pain points of maritime English teaching in vocational colleges by constructing a "pre-class intelligent diagnosis – in-class scenario-based training – post-class intelligent consolidation" three-dimensional closed-loop classroom enabled by generative AI. By reviewing high-quality domestic and international literature, it clarifies the triple research background of industry, policy, and pedagogy, and deeply analyzes the four core problems of disconnected processes, lack of differentiation, shallow technology use, and static evaluation in current three-dimensional classrooms. It details the architecture, refines the implementation strategies by dimension, and establishes a three-tier support system for technology, faculty, and evaluation. Teaching practice has proven that this model effectively breaks down teaching barriers, addresses practical training gaps, and implements differentiated instruction, significantly improving students' maritime English communication competence for the workplace. Additionally, the model is low-cost, easy to operate, and replicable, making it fully adaptable to routine teaching in Chinese vocational colleges. It provides a mature practical framework for the digital reform of maritime English education.

References

[1] Li L. Bibliometric Analysis of Maritime English Research in China [J]. Vocational Education Research, 2022(08):89-94.

[2] Chen X. Modular Curriculum Construction of Maritime English in Vocational Colleges[J]. Transport Vocational Education, 2024(03):45-48.

[3] Liu M. Generative AI in ESP Teaching[J]. Computer-Assisted Foreign Language Education, 2023(02):36-42.

[4] Zhao Y. Generative AI-Enabled Differentiated English Teaching[J]. China Vocational and Technical Education, 2025(12):67-72.

[5] Zhou Y. Closed-Loop Instruction in Vocational English[J]. Vocational Horizon, 2024(05):56-60.

[6] Wu H. Communicative Competence Evaluation for Seafarers[J]. Journal of Shanghai Maritime University, 2025,46 (02):97-103.

[7] Mu C. Generative AI in Maritime English Design[J]. Maritime Education Research, 2025(02):96-100.

[8] Lin D. IMO English Standards and Implications[J]. China Navigation, 2023,46(03):112-116.

[9] Sutrisno A, Hidayat M. The Role of English in Merchant Marine[J]. E-Jurnal Universitas Negeri Manado, 2023(01):22-29.

[10] Purnama N F, Dirgantoro A R. AI Adoption in Maritime English[J]. Atlantis Press, 2023(11):45-52.

[11] Gao J. Shipping Companies' English Requirements[J]. Waterway Management, 2024,46(07):45-48.

[12] Ministry of Education. Digital Transformation Plan for Vocational Education[Z].2022.

[13] Jin H, Liu M. Intelligent Foreign Language Education[J]. Computer-Assisted Foreign Language Education, 2025(03):1-8.

[14] Chen M. Proficiency Differences in Vocational Students[J]. Vocational Education Research, 2023(11):78-82.

[15] Wang R. Closed-Loop Teaching in Vocational English[J]. Vocational Technology, 2023(09):67-71.

[16] Chen J. Differentiated Preview Resources[J]. Vocational Education Research, 2023(07):65-69.

[17] Zheng X. Classroom Interaction in Vocational English[J]. Vocational Technology, 2024(02):56-60.

[18] Guo F. Closed-Loop Breakage in Vocational Foreign Language Teaching[J]. Vocational Horizon, 2023(10):55-59.