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Research on the Construction of an Intelligent Teaching Ecosystem for the "Introduction to Artificial Intelligence" Course Based on Maritime Characteristics

Taizhi Lv *

School of Information Engineering, Jiangsu Maritime Institute, Nanjing 211170, China

*** Corresponding author Email:** lvtaizhi@163.com)

Abstract: Under the broader context of the country's comprehensive advancement of the "Artificial Intelligence+" action and the digital transformation of vocational education, deeply integrating universal artificial intelligence technologies with industry-specific vertical scenarios has become the core task of AI general education course reform in higher vocational institutions. Set against the pedagogical practice of general education, this paper addresses the core pain points of higher vocational students, including a weak foundation in information technology, a lack of cross-disciplinary integration awareness, and the existence of a "cognitive black box" in AI applications. Accordingly, it explores and constructs an intelligent teaching ecosystem for the Introduction to Artificial Intelligence course based on maritime characteristics. This ecosystem utilizes the Chaoxing platform as its digital pedagogical foundation and features customized, industry-specific vertical large language model agents as its core drivers, establishing an innovative closed-loop driving mode of "intelligent teaching assistant + AI scenario generation + dynamic learning situation evaluation." In terms of instructional implementation, the course reconstructs a modularized teaching content framework characterized by a "four-layer progression and scenario-driven" approach, and deploys an innovative classroom teaching model of "five-step progression and six-in-one integration." Concurrently, relying on a cloud-based AI intelligent learning system, a multi-dimensional evaluation system has been established to synthesize formative evaluation, summative evaluation, and personalized value-added evaluation. Practical implementation demonstrates that this ecosystem significantly enhances students' three-dimensional target achievement, practical operational capability with AI tools, and cross-disciplinary innovative literacy tailored to the smart shipping sector. Ultimately, it provides a reproducible and generalizable standardized implementation path for AI-empowered classroom teaching reforms in similar vocational colleges.

Keywords: Vocational Education; Introduction to Artificial Intelligence; Intelligent Teaching Ecosystem; Maritime Characteristics; Value-Added Evaluation.

1. Introduction

1.1. Research Background

As the core driving force of the new round of technological revolution and industrial transformation, artificial intelligence (AI) is profoundly reshaping global competitive landscapes and national development momentum. The state has intensively deployed "Artificial Intelligence+" actions to promote the deep integration of AI across various economic and social domains, placing higher demands on the digital literacy and intelligent collaborative capabilities of the workforce. Future high-quality technical and skilled talents must possess not only post-specific professional competencies but also composite qualifications to collaborate with AI and empower post innovation through intelligent systems.

The rapid evolution of AI is also transforming vocational education at a structural level. The Action Plan for "Artificial Intelligence + Education" (Tech & Info〔2026〕No. 1), jointly issued by five departments including the Ministry of Education, explicitly requires a timely assessment of the structural impact of AI on vocational education. It mandates promoting the intelligent upgrading of traditional majors, scientifically designing the "Artificial Intelligence+" curriculum system, and enhancing the alignment between major setting and industrial development.

Jiangsu Maritime Institute, as a higher vocational college with distinctive shipping characteristics, faces the rapid iteration trends of industries such as smart shipping and smart ports. Within this context, the traditional Introduction to Artificial Intelligence general course has exposed numerous maladaptations. On the one hand, universal AI technologies and industry vertical scenarios are distinctly disconnected, making it difficult for students to transform abstract algorithms and models into capabilities for solving practical maritime shipping problems. On the other hand, the traditional classroom teaching model relies on single, uniform methods, failing to meet students' personalized and differentiated learning needs.

Therefore, constructing an intelligent teaching ecosystem oriented toward maritime characteristics—one that deeply integrates digital teaching platforms and agent applications, and achieves full-process dynamic evaluation—is of vital practical significance for improving the teaching quality of general higher vocational courses. Furthermore, it holds profound strategic value for promoting the deep industry-education integration of "AI + vocational education".

1.2. Domestic and Foreign Research Status

Research on general AI education abroad commenced early, gradually expanding from computer professional education to AI literacy cultivation oriented toward all learners. Long and Magerko proposed that AI literacy should encompass core competencies such as understanding basic AI concepts, identifying AI applications, evaluating AI systems, collaborating with AI, and focusing on ethical implications [1]. Laupichler et al. further pointed out that AI literacy is not merely a single tool competency, but rather a comprehensive capability involving technical understanding, tool usage, critical evaluation, ethical judgment, and social impact perception [2].

With the popularization of generative artificial intelligence, content such as prompt engineering, output validation, data privacy, academic integrity, and human-machine collaboration has been rapidly incorporated into the scope of general education. UNESCO's 2024 publication, AI Competency Framework for Students, proposed 12 competency modules consisting of four dimensions (human-centered mindset, AI ethics, AI techniques and applications, and AI system design) and three progressive levels (understand, apply, and create) [3]. Similarly, Carnegie Mellon University utilizes AI knowledge, affect, and thinking as content dimensions, cultivating students' AI literacy through three distinct paths: general education, minors or additional majors, and research projects [4].

Driven continuously by national policies, the research and practice of domestic general AI education have developed rapidly. In April 2025, nine departments including the Ministry of Education jointly issued the Opinions on Accelerating the Promotion of Educational Digitalization (Education-Office〔2025〕No. 3), explicitly proposing the construction of "universal + characteristic" university AI general education courses [5]. In 2026, the Action Plan for "Artificial Intelligence + Education" (Technology & Information〔2026〕No. 1) by five departments including the Ministry of Education further required promoting AI to become a public foundational course in universities and driving the intelligent upgrading of traditional vocational education majors [6]. In 2025, a total of 110 research projects on information technology and AI general course teaching reform in higher vocational colleges nationwide were approved, indicating that this field has entered a systematized advancement stage [7].

Regarding domestic academic research, existing achievements are mainly concentrated in the following three directions:

Research on the AI Literacy Framework: Guan et al. constructed an AI literacy framework for vocational college students with a three-layer progressing structure of "general literacy—professional skills—industry competencies," covering seven core dimensions: human-oriented AI awareness, social responsibility, basic knowledge and skills, thinking and behavior, collaboration and communication, professional competencies, and post competencies [8]. Li et al. proposed utilizing the concept of "universal-professional penetration" to break through the limitations of traditional "addition" type general courses, constructing a vocational mind structure with algorithmic model thinking, data critical thinking, human-machine collaborative thinking, and an intelligent ethical outlook as the core [9].

Research on Course Systems and Teaching Models: Yuan et al. aimed at the "4V challenges" (student requirement diversity, knowledge update speed, teaching scale expansion, and core value shaping) faced by university AI general courses. Based on the zone of proximal development theory and cognitive flexibility theory, they constructed differentiated teaching models for students with three different disciplinary backgrounds: science, engineering, agriculture, and medicine; humanities and social sciences; and humanities and arts, verifying them with the general AI course at Zhejiang University as a pilot [10]. The Artificial Intelligence Application course at Shenzhen Polytechnic University stands on the trinity cultivation goal of "knowledge—thinking—practice," achieving the organic unification of "teaching artificial intelligence well" and "teaching with artificial intelligence"[11]. Zhao et al. proposed hierarchical AI course teaching models, setting the course content into four levels for science, engineering, liberal arts, and arts to suit methods to the student and situation [12].

Characteristic Industry Practice Exploration: Xiao et al. researched AI general courses oriented toward the broad tourism professional category and proposed "general popularization and professional fusion" course goal-setting ideas along with a "three-stage five-loop" teaching flow [13]. Wang et al. proposed multi-channel models for integrating AI education into navigation professional bachelor education curriculum system construction [14]. Yin et al. strengthened sports AI general course construction from a curriculum system perspective [15].

In light of these contexts, existing research has accumulated a solid foundation regarding AI literacy frameworks and general course construction. However, characteristic industry depth integration remains insufficient, and the linkage between the course system and smart technologies remains weak. This study, based on the specific institutional running characteristics of our maritime institute, focuses on conducting systematic research under the AI4M (AI for Maritime) concept, possessing vital research value and practical significance.

2. Overall Design of the Intelligent Teaching Ecosystem

2.1. Closed-Loop Ecosystem Architecture

The intelligent teaching ecosystem of this course breaks the teacher-centric linear model of classroom teaching. Instead, it constructs a dual-core closed-loop ecosystem interaction empowered by the Chaoxing platform as the spatial base and industry vertical agents as the wisdom core. The core architecture of this ecosystem is realized through the seamless loop of three major modules: "intelligent teaching assistant guidance -> AI scenario generation practical operation -> dynamic learning situation precise evaluation". Its technical and application architecture relationships are illustrated in Figure 1. Under this architecture, the role of the teacher shifts into a designer and facilitator of the intelligent teaching ecosystem. Concurrently, the large language model agents transform into all-weather, "24-hour intelligent assistants" and "industry scenario generators," allowing students to conduct exploratory learning within a digitized "smart maritime cabin" that highly replicates actual working environments.

2.2. Four-Layer Progression, Scenario-Driven" Teaching Content Reconstruction

To resolve the key pain points of higher vocational students, such as their tendency to experience confusion when faced with purely theoretical large-model concepts and the disconnect between universal AI tools and industrial operations, the curriculum team reconstructed a modularized and structured body of teaching content centered around maritime application scenarios. Breaking away from traditional chapter arrangements, the content is partitioned into a four-layer progressive structure: "General Cognition → Vertical Technology → Industry Practice → Frontier Ethics," completely embedding real-world maritime engineering cases like smart shipping, smart ports, and digitized ship maintenance:

Layer 1: Core Principles of Generative AI and General Cognition. This layer demystifies the "cognitive black box" of large language models. It guides students to comprehend prompt engineering and the fundamental laws of model emergence, thereby solidifying the underlying cognitive foundation required for digital transformation.

Layer 2: Application of Maritime Vertical AI Technologies. Introducing fundamental technical modules such as "computer vision-based ship defect identification" and "maritime AIS (Automatic Identification System) data trajectory cleaning," this layer allows students to master the practical deployment paths of computer vision and data intelligence within the maritime domain.

Layer 3: Practical Scenarios of Smart Shipping. Modeled after authentic engineering projects from strategic enterprise partners (e.g., Jiangsu Port Group, Yangtze River Delta Shipping Research Institute), this layer develops highly authentic, virtual practical tasks, such as the construction of the "Hairui Zhiwei" intelligent ship inspection agent.

Layer 4: AI Ethics, Compliance, and Regulatory Framework. This layer encourages students to critically evaluate the legal boundaries of AI in shipping automation, data security compliance, and the requirements of professional ethics in the era of human-machine collaboration.

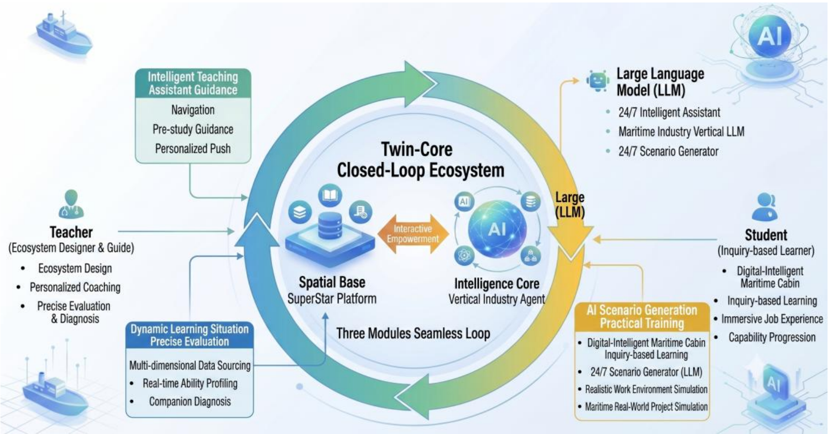

Figure 1. The overall architecture of the intelligent teaching ecosystem

2.3. Dynamic Learning Situation Profiling Mechanism Based on Multi-Dimensional Needs

To thoroughly execute the principle of "suiting instructional methods to individual aptitudes," the ecosystem sets up multi-dimensional channels for acquiring student needs alongside a dynamic learning situation profiling mechanism. During the initial phase of the course, the system inventories students' learning pain points and future career anxieties via the Chaoxing platform.

Midway through the term, a cloud-based AI intelligent learning system tracks and captures real-time student interaction data from the platform. Utilizing radar charts, the system generates a dynamic individual profile across three dimensions: information technology foundation, cross-disciplinary integration awareness, and AI tool operational proficiency. Consequently, instructors can instantly identify students who lack an industry application perspective or those who habitually utilize large models mechanically without logical filtering, enabling immediate tactical teaching adjustments and precision resource delivery.

3. Intelligent Teaching Implementation Path

3.1. Intelligent Teaching Base Based on the Chaoxing Platform

Following a comprehensive intelligent upgrade, the Chaoxing platform has deeply integrated advanced AI capabilities, serving as a solid digital foundation for the curriculum. Connected directly to the DeepSeek large model, the platform provides tailored, personalized services for both faculty and students across the entire pre-class, in-class, and post-class timeline. Every course features an integrated AI workbench covering preparation, instruction, and assessment, supporting 35 unique pedagogical application scenarios including automated item generation, AI-generated courseware, smart grading, automated programming code testing, AI classroom evaluation, and AI learning data analysis.

Drawing upon ChaoXing's vast library resources and its proprietary Huiya large model, the platform forms an educational vertical knowledge base from which teachers can instantly compile presentations, test banks, AI lesson plans, and practical tasks. The platform's open AI system conducts precise analyses of student learning data, supplying robust data points that assist teachers in refining course outlines and adjusting instructional focuses.

Within the execution of this course, the Chaoxing platform serves not only as the interactive media for resources but also acts as the primary "data collection sensor" for the entire ecosystem. Throughout the full lifecycle of teaching delivery, the platform executes standardized data capture and control tasks:

Pre-class Phase: Publishing cutting-edge shipping guidance case sheets -> Triggering Chaoxing check-ins -> Recording chapter task completion rates and initial general knowledge diagnostic tests.

In-class Phase: Pushing real-time interactive quizzes -> Collecting classroom participation points -> Managing multi-party peer evaluation data during group presentations.

Post-class Phase: Archiving practical project assignments -> Syncing with the cloud AI learning system -> Deriving individual longitudinal growth trajectories.

By maintaining a continuous digital trail of student behaviors across all times and spaces, the teaching team has successfully abandoned the loose, macro-level evaluation approach typical of traditional final exams, creating a rich source of raw data for dynamic student profiling.

3.2. Construction of Practical Teaching Resources Based on Agents

Rooted in our institutional identity of maritime shipping, the course matches the school's six main professional groups by designing six distinct practical projects tied closely to professional specialties. For instance, the Navigation Group implements the "Hairui Zhiwei" intelligent ship inspection agent construction project. The project assignment revolves around typical high-risk industrial scenarios encountered during ocean-going engine room inspections (e.g., deck rust area exceeding safety benchmarks, micro oil leaks in engine piping, sudden high-frequency radar antenna faults). It guides students to employ AI techniques for maritime AIS data cleaning, defect image identification, and route maintenance scheduling. By translating abstract AI algorithms into digital tools that resolve actual front-line shipping troubles, the project dispels the "cognitive black box" of AI in general education, focusing intensely on fostering cross-disciplinary integration awareness and human-machine collaborative operational skills.

Throughout the instructional design process, the teaching team engineered a highly customized "agent workflow," achieving an agile, digitalized restructuring of practical resources. This workflow is organized into three core stages:

Data Alignment and Injection: The faculty uploads heterogeneous multi-source data—including the Introduction to Artificial Intelligence national curriculum standard, smart shipping post-skill codes, and raw industrial inspection logs—into the agent base.

Role and Constraint Configuration: Instructors configure a dual virtual persona for the agent, combining a "senior maritime education expert" with an "experienced ocean-going chief engineer," while embedding logical constraints that require the automatic translation of complex engineering terms into student-friendly vocational language.

Prompt Iteration and Tuning: Teachers write multi-turn Chain-of-Thought (CoT) prompts, driving the agent to filter content, reorganize logic, and adaptively smooth text, rapidly converting disorganized industrial cases into teaching modules that match higher vocational students' cognitive stages.

Relying on this intelligent workflow, the agent fuses course standards, project requirements, and technical references to co-create a comprehensive, three-in-one digital practical outcome consisting of task instructions, workbooks, and rubrics.

Reconstructing "Scenario-Decoupled" Modern Task Sheets: The agent adaptively de-sensitizes and decouples raw industrial operational logs based on core knowledge benchmarks from the course standards. It generates phased, customized task sheets complete with initial ship fault parameters and strict deadlines, mapping out a clear direction for human-machine collaboration.

Co-building "Human-Machine Collaborative" Loose-Leaf Workbooks: Utilizing practical project operations data, the agent assists in compiling the Human-Machine Collaborative Loose-Leaf Workbook. The workbook uniquely incorporates a prompt iteration log and an AI error-correction section. It requires students to document the journey of refactoring their prompts from broad trials to precise executions, turning the workbook into a personalized digital diary of their shared growth alongside AI.

Customizing "Behavioral Data Value-Added" Evaluation Rubrics: Benchmarked against tier-one enterprise competitions and professional certification standards, the agent reverse-engineers a multi-dimensional dynamic evaluation matrix. The matrix integrates process data—such as the frequency of AI tool utilization, the count of solution refactoring iterations, and the precision of commands used to correct AI "hallucinations"—into the core evaluation engine of Chaoxing and the cloud learning system, extending customized value-added incentives to students of all starting baselines.

This innovative instructional design powered by agent workflows dramatically improves the speed at which teachers develop industry-focused resources. Furthermore, it ensures that practical teaching resources stem from actual environments, the learning process depends on smart interactions, and assessment standards connect directly with the industrial frontier.

3.3. Landing of the "Five-Step Progression, Six-in-One" Classroom Teaching Innovation Model

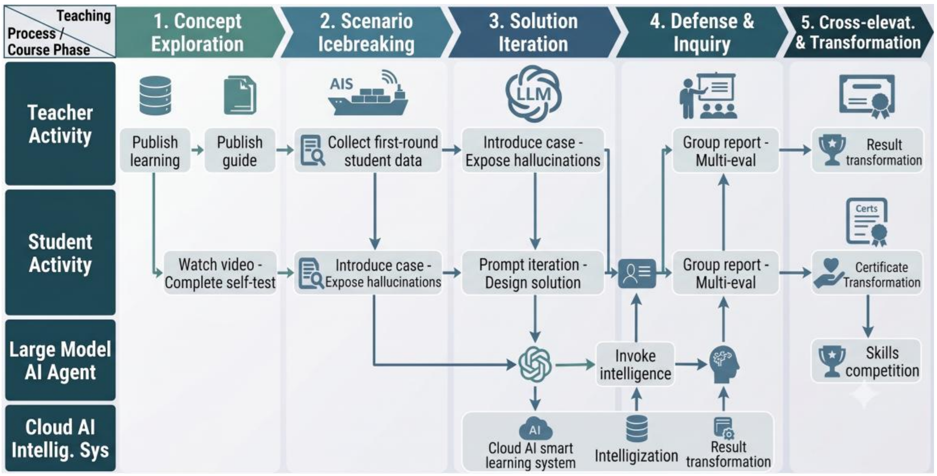

Figure 2. The implementation flow of the classroom teaching innovation model

Supported by the twin-core smart ecosystem, the teaching team has implemented the "five-step progression, six-in-one" innovative classroom model, driven by the philosophy of "scenario-driven, practice-based talent cultivation". Taking the core unit "Construction of the 'Hairui Zhiwei' Intelligent Ship Inspection Agent" as a primary case, the concrete implementation workflow proceeds as shown in Figure 2. Through the progressive layers of this five-step progression, abstract and dense AI algorithm concepts turn into digital tools that students can confidently control to operate a virtual ship inspection. Cross-disciplinary integration awareness and practical innovation capabilities are built during this full-lifecycle collaboration. Intelligent Multi-Dimensional Evaluation System and Effectiveness Analysis

3.4. Multi-Dimensional Evaluation Design

To thoroughly and objectively measure students' developmental trajectories within the intelligent teaching ecosystem, this course constructs a comprehensive evaluation framework utilizing a cloud-based AI intelligent learning system. The weight of the traditional end-of-term written examination has been significantly scaled down to 30%, shifting 70% of the grading weight to full-lifecycle formative evaluations.

Formative evaluation no longer relies solely on subjective grading by the instructor; instead, it blends assessments from corporate engineers, classroom teachers, the individual student, and the automated AI evaluation system. Meanwhile, the summative evaluation abandons rote-memorization objective questions. It aligns completely with professional skill assessments and AIGC competition standards from primary industry enterprises, using group-delivered "maritime AI application practical project outcomes" and "live solution defense presentations" for a multi-dimensional, comprehensive roadshow review.

3.5. Individual Differentiated Value-Added Evaluation

The primary innovation of this intelligent teaching ecosystem lies in its inclusion of full-lifecycle value-added evaluation. When students log into the cloud AI learning system for human-machine collaborative tasks, the background behavioral capture engine records non-traditional critical event data. The core indicators and calculation tracking dimensions of this value-added evaluation are detailed in Table 1 below:

Table 1. The matrix of value-added evaluation indicators in the cloud learning system

Evaluation Dimensions	Precisely Captured Indicators	Value-Added Evaluation Orientation
Digital Behavioral Engagement	Task completion, check-in, forum quality	Attitude shift: passive to active peer assistance
Human-Machine Collaboration Depth	AI tool call frequency, prompt length, structural alignment	Use AI as productivity tool, avoid superficial chat
Logical Reasoning & Error Correction	Refactoring iterations, corrections for AI hallucinations	Reward self-correction progress, not first-draft ability
Industry Application Output Capacity	Case matching, remote assistance frequency, execution success	Cross-disciplinary depth in applying AI to maritime vertical

This evaluation model places a primary emphasis on taking the student's past self as the point of reference. For example, if a student from a non-computing major begins the course with a low AI proficiency profile, but records 18 system-monitored iterations while optimizing the prompt architecture for the "ship inspection agent construction" task, the system will track this effort. Even if the final solution's technical precision is slightly lower than that of an advanced IT student, the system and instructor will award a high value-added score due to the student's outstanding iteration count and personal growth curve. This approach strongly boosts higher vocational students' self-efficacy, helping every student find their path to success.

3.6. Analysis of Application Effectiveness

The intelligent teaching ecosystem has completed two full cycles of instructional validation at Jiangsu Maritime Institute, yielding positive pedagogical outcomes and driving a shift from knowledge acquisition to skill mastery:

Acquiring Wisdom to Anchor Core Generative AI Knowledge: Big data statistics from the Chaoxing platform reveal that students' three-dimensional target achievement scores across generative AI core principles, vertical scenario applications, and AI ethics compliance have substantially improved.

Applying Knowledge to Hone Full-Scenario Practical AI Skills: Under the influence of this reformed ecosystem, students' human-machine collaboration and operational capacities have experienced a qualitative change. The curriculum group successfully hosted a campus-wide Generative AI Skills Competition, highlighting a large volume of outstanding projects. Students can now design intricate technical solutions using large models, laying a solid foundation for provincial and national innovation challenges, while driving an upward trend in professional certification pass rates.

Radiating Influence to Demonstrate the Synergy of Industry-Education Integration: Relying on deep cooperative platforms like the Yangtze River Delta Shipping Research Institute and Jiangsu Port Group, the shipping-specific AI case library and virtual simulation standards produced by this project have been shared with regional brother institutions. The project team has conducted multiple digital teaching workshops, offering valuable, practical experiences unique to our institute to guide the broader educational digitalization journey of similar vocational colleges.

4. Summary and Outlook

4.1. Summary of Research Work

This paper systematically details the construction, research, and practical application outcomes of an intelligent teaching ecosystem for the Introduction to Artificial Intelligence course based on maritime characteristics. Addressing the core difficulties of higher vocational education amid the AI wave, the study achieves significant innovations and breakthroughs across three key levels:

Architectural Innovation: It successfully builds a three-in-one closed-loop ecosystem combining "intelligent teaching assistant + AI scenario generation + dynamic learning situation evaluation". By binding the data capacity of Chaoxing with the scenario generation power of vertical agents, it achieves deep integration between smart technologies and daily teaching routines.

Content and Modal Innovation: Centered on the school's clear maritime identity, the framework breaks down traditional subject silos to reconstruct a modular course structure based on a "four-layer progression and scenario-driven" approach. It integrates real-world industrial operations like ship inspections and uses a five-step progressive model, eliminating students' "AI cognitive black boxes" and bridging the gap in cross-disciplinary integration.

Evaluation Innovation: Supported by a cloud-based AI intelligent learning system, the model integrates process metrics—such as tool call frequencies and solution iteration counts—into a full-lifecycle, personalized value-added evaluation framework. This moves beyond single-dimensional final testing, motivating students from all baselines and delivering genuinely tailored instruction.

4.2. Deficiencies and Future Outlook

Although the construction of this general AI course ecosystem has achieved fruitful phase-level educational reform results, certain bottlenecks remain that require fine-grained optimization. For example, as the underlying architecture of generative models evolves rapidly, the customized "Hairui Zhiwei" ship inspection agent requires further enhancement regarding its concurrent processing capacity for multi-modal data streams. Additionally, when managing high-intensity collaborative instruction alongside AI co-tutors, the mechanism for faculty teams to respond agilely and perform secondary interventions based on complex, instantaneous cloud data requires further standardization.

Looking ahead, as large model technologies continue to mature, the project team will deepen its research-production partnerships with the Yangtze River Delta Shipping Research Institute and smart shipping enterprises. On the one hand, we plan to decouple the existing intelligent ecosystem into modular, universal templates, allowing rapid migration into the classrooms of core engineering major groups like computer science and electronic information to maximize technology radiation and demonstration effects. On the other hand, we will explore incorporating advanced embodied intelligence and virtual reality cabin technologies to build a highly immersive, "AI+Smart Maritime" all-scenario open smart classroom, continuously contributing high-quality practical paradigms to support the national strategy for vocational education digitalization.

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