

Generative Artificial Intelligence in Maritime Economic Geography Practice: from the Perspective of the "Double High" Plan's Industry-Education Integration

Xinyi Ma, Aimin Wei*, Hui Wang

Hainan Vocational University of Science and Technology, Haikou, 571126, China

*Corresponding author: 1657042373@qq.com

Abstract: Under the background of the "Double High Plan" to deepen industry-education integration, this research focuses on the teaching reform of the Maritime Economic Geography course, exploring the empowering pathways of Generative Artificial Intelligence. Addressing the pain points in traditional teaching, such as outdated content and insufficient practical experience, the study constructs a "Dual-Driven, Three-Phase Iterative" application model. This model reshapes the curriculum development and implementation process through the synergy of "AI technology" and "industry-education integration." Based on this model, a Project-Based Learning case driven by authentic corporate needs was designed. Students utilized a suite of AI data analysis tools, a domain-specific intelligent agent, and ship maneuvering simulation systems to complete a full decision-making, from route optimization analysis to high-fidelity simulation verification. Practice has shown that the deep integration of Generative AI effectively enhances students' abilities in complex problem-solving, innovative thinking, and adaptability to professional scenarios, providing a systematic solution for dynamic content updating and personalized learning. This research offers an actionable paradigm for the deep integration of artificial intelligence and vocational education teaching.

Keywords: Generative Artificial Intelligence; Maritime Economic Geography; Industry-Education Integration; Project-Based Learning; Curriculum Reform

1. Introduction

As a core course for transportation majors, Maritime Economic Geography is comprehensive and practical. It focuses on global maritime transport systems, port layout, shipping networks, and logistics resource allocation, helping students understand international logistics and trade. However, traditional teaching suffers from outdated content and rigid methods, failing to meet talent-cultivation demands under the High-level Vocational Colleges and Professional Groups Development Plan in China (hereafter referred to as the "Double High Plan").

Table 1 Core Teaching Pain Points of Maritime Economic Geography and Corresponding GenAI Solutions

Traditional Teaching Pain Points	GenAI Solutions	Expected Outcomes
Teaching content lags behind industrial practice	Dynamically generate cases based on real-time shipping data	Course content keeps pace with industrial development
Simplistic teaching methods and lack of interaction	Create virtual port and shipping route simulation environments	Enhance students' learning participation and experience
Insufficient practical teaching resources	Construct digital twin port operation scenarios	Make up for the limitations of practical training conditions
Inadequate personalized learning support	Provide adaptive learning paths based on learning situation analysis	Meet students' differentiated learning needs

2. literature review

In recent years, GenAI application in education has become a global research hotspot. Overseas studies focus on adapting general AI models for educational use, such as OpenAI's GPT series in teaching content generation and automated assessment. Some research emphasizes discipline-specific teaching laws. For example, Cheng (2025) established a GenAI-assisted deep learning model for high school geography and verified its effectiveness in fostering higher-order thinking.

International research centers on personalised learning and automated assessment. Crompton and Burke (2023) noted that AI tools support instruction by content and feedback. Intelligent tutoring and adaptive platforms enhance engagement and streamline administration (Lim et al., 2023). Topic modelling identifies automated grading, chatbot learning, and personalised recommendations as key directions (Tao et al., 2025), though evidence remains concentrated in higher education.

In vocational education, GenAI integration with professional courses is growing. However, dedicated research on Maritime Economic Geography remains scarce. Existing studies, such as Zhao et al. (2015), focus on traditional teaching improvements without intelligent technology support. Most studies treat GenAI as an auxiliary tool rather than a core driver for curriculum reconstruction under the Double High Plan. This study fills the gap by building a GenAI-driven curriculum model for Maritime Economic Geography. The research follows a framework: Problem-Oriented ,Model Construction , Practical Verification. Methods include literature review, case analysis, and design science research.

GenAI is an AI system that generates multimodal content, featuring originality and interactivity, distinct from analytical AI (Cyberspace Administration of China, 2023). In education, it supports personalised learning (Ministry of Education of the People's Republic of China, 2024). Maritime Economic Geography examines spatial patterns of maritime economies, integrating geography, economics, and logistics (Wang et al., 2023), requiring high timeliness amid digital trade development. Industry-education integration under the Double High Plan (Ministry of Education & Ministry of Finance, 2019) links education and industry chains through school-enterprise collaboration.

Understanding by Design (UBD) theory advocates backward design (Wiggins & McTighe, 2017), guiding GenAI to focus on core abilities rather than technical novelty. Constructivist learning theory highlights knowledge construction through situated practice (Zhu & Hu, 2023), supported by GenAI-created virtual maritime scenarios. Educational ecology theory emphasizes dynamic balance among educational elements (Gu & Li, 2023; Zheng & Wang, 2021), providing a holistic framework for analysing GenAI's systemic impact on curriculum reform.

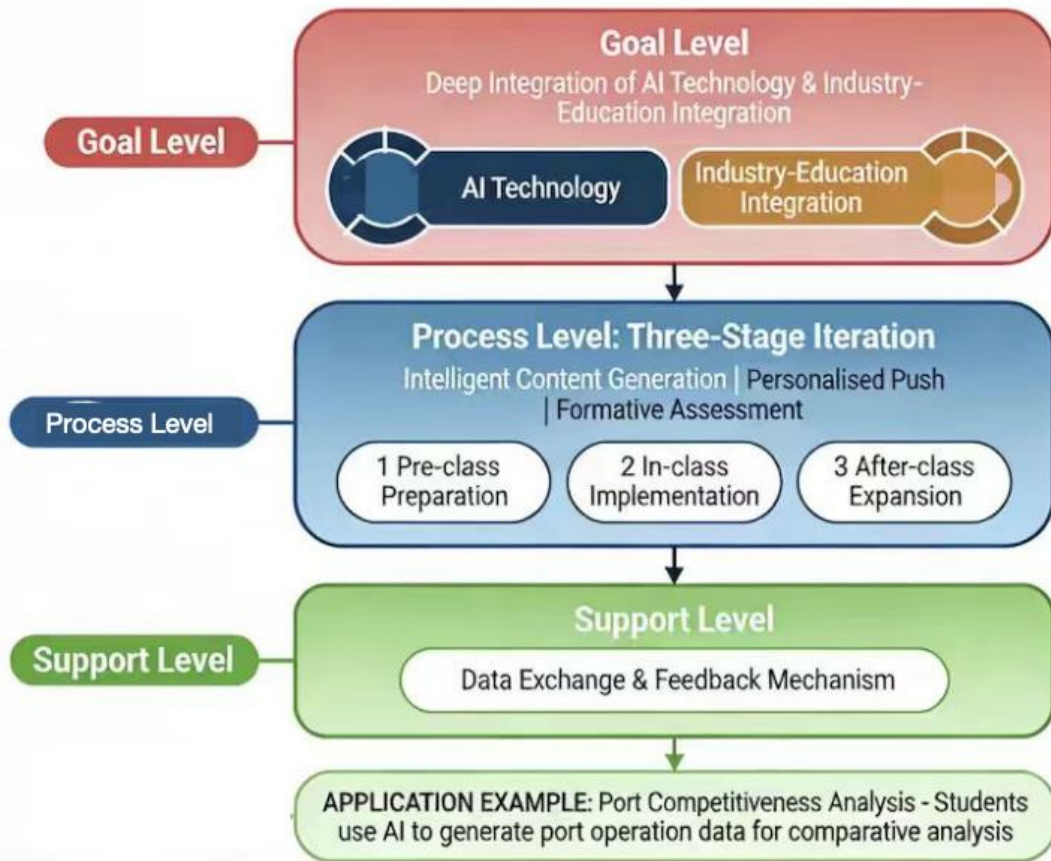
3. Construction of an Application Model for GenAI-Empowered Development of the Maritime Economic Geography Course

Targeting three contradictions in traditional Maritime Economic Geography, this study proposes three GenAI empowerment principles for curriculum development under the Double High Plan: two-way connection, dynamic generation and immersive experience.

3.1 Design of the "Dual-Drive, Three-Stage Iteration" Model

Based on the above principles, this study constructs a "Dual-Drive, Three-Stage Iteration" model for GenAI-empowered development of the Maritime Economic Geography course (see Figure 1). The model includes three levels: the goal level, the process level and the support level, forming a complete curriculum development system.

Figure 1 Framework of the "Dual-Drive, Three-Stage Iteration" Model



The model consists of the dual drives of AI technology and industry-education integration, with a data exchange and feedback mechanism as the support. The process level includes three iterative stages of pre-class preparation, in-class implementation and after-class expansion, covering intelligent curriculum content generation, personalised push and formative assessment. The goal level is to realize the deep integration of AI technology and industry-education integration in curriculum development. For example, in the port competitiveness analysis project, students use AI to generate port operation data for comparative analysis.

3.1.1 Dual-Drive Mechanism

The dual drivers are AI technology and industry-education integration: AI enables intelligent curriculum content generation, personalized delivery and formative assessment, while industry-education integration aligns curricula with industrial needs via school-enterprise collaboration. They interact synergistically through data exchange and feedback—AI converts enterprise cases into teaching tasks and analyzes students' performance to optimize enterprise talent training. This mechanism shifts curriculum goals from knowledge transmission to fostering innovation and critical thinking, with GenAI acting as a collaborator for students to explore complex issues independently, such as analyzing port operation data to draw their own conclusions in relevant projects.

3.1.2 Three-Stage Iteration Process

Curriculum development features a spiraling upward iterative process consisting of pre-class preparation, in-class implementation and after-class expansion.

In the pre-class phase, GenAI analyzes students' knowledge base via pre-tests to formulate personalized learning paths and generates teaching resources like port image sets, all of which undergo professional teacher review to ensure scientific validity and pedagogical applicability.

In in-class implementation, GenAI supports scenario creation, inquiry guidance and formative assessment. For the spatial content of Maritime Economic Geography, it generates interactive maps for intuitive learning; for complex tasks such as shipping route optimization, it enables group-based project learning with real data analysis, while tracking progress in real time and providing targeted feedback.

In after-class expansion, GenAI facilitates personalized review and knowledge transfer by generating differentiated exercises for knowledge consolidation. It also designs cross-scenario research topics (e.g., COVID-19's impact on global shipping networks) for advanced learning and develops virtual internship projects, allowing students to experience enterprise work online and offset the shortage of practical training opportunities.

3.2 Characteristics and Innovations of the Model

The "Dual-Drive, Three-Stage Iteration" model features dynamic curriculum updates aligned with industrial development, virtual scenarios breaking classroom spatio-temporal constraints, and precise AI-based learning evaluation with personalised reports. Its core innovation elevates GenAI from a mere instrumental tool to a core curriculum construction element, forming a technology-empowered education paradigm that redefines teaching content, activities and assessment as an inherent transformative force.

Table 2 Comparison Between the Traditional Model and the GenAI-Empowered Model of the Maritime Economic Geography Course

Teaching Link	Traditional Model	GenAI-Empowered Model	Advantage Comparison
Pre-class Preparation	Teachers manually search for materials and make static PPTs	AI automatically generates personalised learning paths and interactive resources	Improved efficiency of resource generation and enhanced targeting
In-class Implementation	Teacher-centred lecturing with students passively listening	Immersive project-based learning with AI providing real-time inquiry support	Increased student participation and strengthened practical ability
After-class Expansion	Unified assignment of homework with lack of differentiation	AI generates personalised extended tasks based on learning situations	Improved effect of knowledge transfer and realisation of personalised learning
Assessment Method	Reliance on final written examinations with emphasis on knowledge memorisation	Formative assessment as the main method with AI recording and analyzing learning trajectories	More comprehensive assessment and more timely feedback

As shown in Table 2, the application advantages of GenAI in curriculum teaching are mainly reflected in the above four core links through the comparison between the traditional model and the GenAI-empowered model of the Maritime Economic Geography course, which optimizes the teaching process and improves teaching quality in an all-round way:

Pre-class preparation link: GenAI automates personalized learning path design and interactive resource generation (e.g., maps, cases), replacing teachers' inefficient manual material collection and static PPT creation. Its core merit lies in boosting resource development efficiency and enabling targeted resource delivery based on learning analytics, thus laying a precise foundation for in-class teaching.

In-class implementation link: GenAI breaks the rigid teacher-centered lecture model by building immersive scenarios and supporting project-based inquiry (e.g., shipping route optimization). It tracks real-time learning progress and delivers targeted feedback, significantly elevating students' classroom engagement and strengthening their practical inquiry and problem-solving competencies.

After-class expansion link: GenAI addresses the traditional flaw of uniform homework and undifferentiated guidance by generating personalized exercises and cross-scenario tasks (e.g., industrial hotspot research, virtual internships) per students' in-class performance and knowledge mastery. It enhances knowledge transfer efficiency, realizes student-centered teaching, and compensates for the lack of practical training opportunities in traditional pedagogy.

Assessment method link: GenAI replaces the one-sided traditional assessment model of final written exams focused on knowledge memorization with formative assessment as the core, recording

full learning trajectories and conducting systematic effect analysis. It makes assessment more comprehensive and objective, enables timely feedback, and helps teachers adjust teaching strategies promptly and students remedy knowledge gaps efficiently.

4. Practical Cases and Effect Analysis Based on Industry-Education Integration Under the Double High Plan

4.1 Case Background and Design

A teaching experiment was conducted with a university's Double High Program Maritime Navigation Technology major (with stable enterprise cooperation) to verify the model. Two equivalent parallel classes were set up: the experimental class using the GenAI model and the control class with traditional teaching, for a semester-long experiment on international shipping route analysis and optimization. The experimental class adopted GenAI-supported PBL based on real enterprise demand for China-Europe container route optimization. Students worked in groups as freight forwarders to analyze real-time data with AI tools, with GenAI providing virtual scenarios, data analysis tools and intelligent consulting support throughout the project.

4.2 Implementation Process and Key Links

The project proceeded through three GenAI-integrated stages: initiation, design and display. Initiation saw GenAI create virtual demand scenarios, push learning resources and enable virtual expert communication for students. In design, GenAI provided real-time shipping data, optimization models and collaboration support, with teachers acting as learning instructors. For display, AI generated visual charts and simulated customer questions for scheme polishing, followed by online comments from enterprise experts to deepen industry-education integration.

4.3 Core AI and Simulation Tools

The project upgraded AI-PBL tasks per enterprise needs to integrate shipping route planning with intelligent ship decision-making, requiring students to design optimal routes and verify decisions' practical impact via realistic ship maneuvering simulation.

Table 3 List of Core AI and Simulation Tools

Category	Tool Name	Specific Application and Role in the Project	Advantages/Characteristics
Real-world Data Analysis and Decision-Making	Microsoft Copilot	Macroeconomic market analyst: Inquiring real-time SCFI, Baltic fuel prices, congestion indexes of major global ports (e.g., Lloyd's Maritime Data). Providing real-time market input for the economic analysis of shipping routes.	Free, internet-connected, and with extensive information, serving as a "window" connecting classrooms with the real shipping market.
	ChatGPT Advanced Data Analysis	Shipping route optimization modeler: Processes structured data (port rates, canal tolls, distances), builds total cost and time models, and conducts What-If scenario simulations (e.g., fuel price hikes, canal congestion surcharges).	Strong data processing and modeling capabilities, transforming experience-based decision-making into data-driven decision-making.
GenAI Intelligent Partner	Haike Xiaozhi (Specialised AI)	Enterprise internal expert consultant: Provides domain knowledge Q&A on ship maneuvering characteristics, port regulations and Hainan Free Trade Port policies.	Highly domain-specific, perfectly integrating shipping professionalism with AI, serving as the knowledge core and authenticity guarantee of the project.

Category	Tool Name	Specific Application and Role in the Project	Advantages/Characteristics
	General Large Models (e.g., DeepSeek)	General project collaborator: Assisting in scheme text polishing, report PPT conception, brainstorming, and serving as a supplement to Haike Xiaozhi.	Strong versatility, supporting complex logical reasoning and creative generation.
Ship Maneuvering Simulation	180/360-degree Ship Maneuvering Simulation Training Room of Maritime University of Science and Technology	Decision verification & efficiency perception sandbox: Imports AI-optimized shipping routes (port access, canal sections) into the simulator for students' hands-on ship maneuvering and immersive scheme validation. to execute, feeling the actual impact of channel width, water flow and traffic density on the scheme.	Core competitiveness. Materializing and embodying digital schemes, realizing a leap from "paper planning" to "practical operation perception", and cultivating real compound skills.
Data Visualization	Flourish / Tableau	Scheme presentation designer: Integrates AI-analyzed data and simulator-verified conclusions (e.g., time, fuel consumption) to create interactive storyboards/decision cockpits for the final report.	Professional-level visualization, making the complex decision-making process clear at a glance.

As shown in Table 3, the reconstruction of the project process with the integration of GenAI forms a "digital-physical" decision-making closed loop:

a. Market analysis and macro planning: Students use Copilot and ChatGPT to generate 1-2 preliminary digital shipping route optimization schemes focusing on economy and timeliness, based on real enterprise demands and data.

b. Professional evaluation and practical operation transformation: Students submit schemes to "Haike Xiaozhi" for pre-review; the AI raises professional questions and guides groups to convert key scheme sections into executable simulator training tasks.

c. High-fidelity simulation verification and revision: Groups use the ship maneuvering simulation room to execute tasks, record operation data and difficulties, and verify if low-cost selected secondary ports have sound navigation and berthing conditions, which may overturn theoretically optimal but high-risk digital schemes.

d. Iterative optimization and comprehensive decision-making: Students revise the digital model via ChatGPT and consult Haike Xiaozhi based on simulator feedback, iterating schemes to form a data-calculated and simulation-verified intelligent shipping route optimization report.

e. Multi-dimensional achievement display: Students use Flourish to visually present the complete decision-making chain from market data and cost models to simulation verification.

4.4 Effect Analysis and Methods

A multi-method evaluation (test scores, work quality, engagement observation, interviews) was conducted to assess the course effect. Experimental and control classes showed no significant difference in basic knowledge mastery, but the experimental class excelled in complex problem-solving via multidisciplinary and innovative thinking, proving GenAI-PBL's merit for higher-order thinking development. Its shipping route schemes were more feasible, innovative and complete, integrating real-time data and industrial factors to link theory with practice.

The experimental class also had higher learning engagement due to GenAI's real scenarios and instant feedback. Interviews revealed most experimental class students found GenAI made learning more interesting and effective, and hoped for its wider application.

Table 4 Comparison of Learning Effects Between the Experimental Class and the Control Class

Evaluation Dimension	Experimental Class (AI-Empowered)	Control Class (Traditional Teaching)	Difference Analysis
Mastery of Basic Knowledge	Good	Good	No significant difference
Complex Problem Solving	Excellent: Can comprehensively consider various factors to put forward innovative schemes	Average: Mostly apply fixed models	The experimental class is significantly superior to the control class
Learning Interest	Strong: Active in exploring problems	Average: Mostly passive acceptance	The experimental class is significantly higher than the control class
Team Collaboration Ability	Excellent: Clear division of labor and frequent interaction	Average: Formalistic cooperation	The experimental class is superior to the control class
Work Quality	High: Highly feasible and innovative schemes	Average: Mostly standard answers	The experimental class is significantly higher than the control class

5. Conclusion

From the Double High Plan's industry-education integration perspective, this study built and verified a GenAI-empowered Maritime Economic Geography curriculum model, which resolves traditional teaching pain points via dynamic content generation, virtual scenarios and personalized support, boosting students' higher-order thinking and practical abilities.

Theoretically, it elevates GenAI to a core driver for curriculum reconstruction with the "Dual-Drive, Three-Stage Iteration" model, offering new ideas for vocational education reform. Practically, its cases and guarantee system provide reference for similar majors. Notably, GenAI empowers rather than replaces teachers, who focus on irreplaceable instructional design and value guidance.

Future GenAI applications will focus on multimodal integration, adaptive learning and deeper industry-education integration, supporting high-quality maritime talent cultivation through immersive environments and personalized teaching.

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