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

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Abstract: *Under the background of deepening the integration of production and education in the "double high plan", this study explores the empowerment path of generative AI through the teaching reform practice of marine economic geography. Aiming at the disadvantages of outdated traditional teaching content and lack of practical experience, the application mode of "double drive and three-stage iteration" is constructed. On this basis, a real enterprise demand driven project-based learning case is designed. Practice shows that the deep integration of generative artificial intelligence effectively improves students' ability to solve complex problems, innovative thinking ability and adaptability to professional scenes.*

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

1. Introduction

Marine Economic Geography is a core course in transportation related majors, covering knowledge of global shipping systems, port layouts, shipping networks, and logistics resource allocation. However, traditional teaching content is outdated and methods are rigid, which cannot meet the requirements of talent cultivation in China's high-level vocational colleges and professional groups development plan (hereinafter referred to as the "Double High Plan").

Table 1 Core Teaching Pain Points and GenAI

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 the field of vocational education, such as Zhao et al. (2015), emphasis is placed on improving traditional teaching without the support of intelligent technology. This study constructs a GenAI driven marine economic geography curriculum model, following the principles of "problem orientation, model construction, and practical verification". The methods include literature review, case analysis, and design science research.

GenAI is an AI system that generates multi-mode content, which is original and interactive, different from analytical AI (China National Internet Information Office, 2023). In terms of education, it supports personalized learning (Ministry of Education of the People's Republic of China, 2024). Marine economic geography has studied the spatial pattern of the marine economy (Wang et al., 2023), which requires a high degree of timeliness in the development of digital trade. The integration of industry and education under the Double High Plan (Ministry of Education and Ministry of Finance, 2019) links education and the industry chain through school enterprise cooperation.

The UBD theory advocates for reverse design (Wiggins&McTaghe, 2017), guiding GenAI to focus on core competencies rather than technological novelty. The constructivist learning theory emphasizes knowledge construction through situational practice (Zhu&Hu, 2023) and is supported by the virtual ocean scene created by GenAI. The theory of educational ecology emphasizes the dynamic balance between educational elements (Gu&Li, 2023; Zheng&Wang, 2021), providing a comprehensive framework for analyzing the systematic impact of GenAI on curriculum reform.

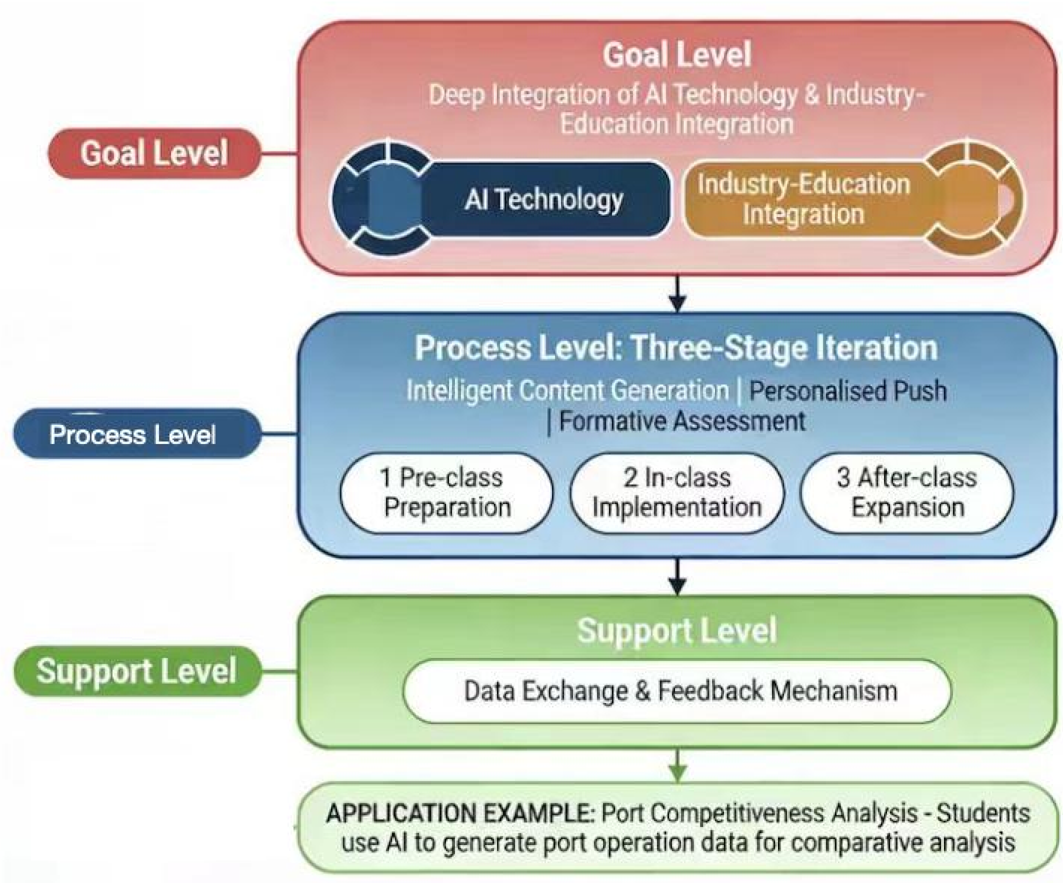
3. Construction of an Application Model

In response to the three contradictions, this study proposes three GenAI weighting principles for curriculum development under the Double High Plan: bidirectional connection, dynamic generation, and immersive experience.

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

According to the above principles, this study constructed a "dual driven, three-stage iterative" model (see Figure 1). This model includes three levels: target layer, process layer, and support layer, forming a complete curriculum development system. 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, namely pre class preparation, classroom implementation, and post class extension, covering intelligent course content generation, personalized push, and formative evaluation. The goal is to achieve deep integration of artificial intelligence technology and industry education integration in curriculum development.

3.1.1 Dual-Drive Mechanism

The dual driving force is the integration of artificial intelligence technology and industry education. Artificial intelligence has achieved intelligent course content generation, personalized delivery, and formative evaluation. This mechanism shifts course objectives from knowledge dissemination to cultivating innovation and critical thinking. GenAI serves as a collaborator for students to independently explore complex problems, such as analyzing port operation data and drawing their own conclusions in related 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: GenAI automates personalized learning path design and interactive resource generation (such as maps and cases), replacing teachers' inefficient manual material collection and static PPT creation.

In-class implementation: GenAI breaks the rigid teacher centered lecture model by building immersive scenarios and supporting project-based queries (such as transportation route optimization).

After-class extension: GenAI improves knowledge transfer efficiency by generating personalized exercises and cross scenario tasks (such as industrial hot topic research and virtual internships) based on students' classroom performance and knowledge mastery.

Assessment GenAI focuses on formative assessment, recording complete learning trajectories, replacing the traditional final written assessment model that focuses solely on knowledge memory.

4. Practical Cases and Effect Analysis

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 through teaching experiments. Two equivalent parallel classes were established: an experimental class using GenAI model and a control class using traditional teaching, to conduct a one semester international shipping route analysis and optimization experiment. The experimental class is based on the actual enterprise needs of optimizing the China Europe container shipping route, using PBL supported by GenAI.

4.2 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.
	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.

4.3 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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