AI-Enhanced Cultivation of Students' Innovative and Practical Abilities in Industry-Specific Universities: A Case Study of Naval Architecture and Ocean Engineering

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Abstract. Amid rapid technological advancements, the wave of artificial intelligence (AI) is sweeping across various fields, with its applications in education becoming increasingly extensive and profound. Industry-specialized universities, as key institutions for cultivating professionals in specific sectors, place great emphasis on fostering students' innovative and practical abilities. This study focuses on universities specializing in naval architecture and ocean engineering, exploring the pathways for AI to empower the cultivation of students' innovation and practical skills. It provides a detailed analysis of the current applications and future trends of AI in naval architecture and ocean engineering, highlighting its multidimensional significance in enhancing students' innovative and practical capabilities. Furthermore, the study proposes comprehensive and actionable cultivation strategies, covering curriculum design, practical platforms, and teaching methods. The findings aim to offer operational and forward-looking insights for industry-specialized universities to leverage AI in boosting students' innovation and practical competencies.

Keywords: Artificial Intelligence, Industry-Specialized Universities, Innovative and Practical, Abilities Cultivation Pathways, Naval Architecture and Ocean Engineering

1 Introduction

Industry-specific universities are a unique part of China's higher education system. With their distinct industry characteristics and advantageous disciplines, they have trained a large number of professional talents for specific industries, promoting the development and progress of industries. Naval architecture and ocean engineering specialty universities, as typical representatives, play an irreplaceable key role in talent cultivation in the field of naval architecture and ocean engineering.

As a pivotal driving force in the new wave of technological revolution and industrial transformation, artificial intelligence (AI) is rapidly reshaping development paradigms and talent demand structures across various industries [1]. In the field of naval architecture and ocean engineering, AI applications are becoming increasingly pervasive,

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demonstrating tremendous potential and value in ship design, manufacturing, marine resource exploitation, ocean environment monitoring. In 1995, Witt et al. [2] introduced the concept of applying artificial intelligence (AI) methods to the ship guidance problem. The integration of AI technologies into maritime education represents both a strategic response to technological evolution and a transformative approach for developing future-ready competencies. As evidenced by recent advancements in marine AI applications, these technologies are revolutionizing professional practice and consequently reshaping educational requirements. Altunkaynak et al. [3] demonstrated that integrating Discrete Wavelet Transform (DWT) with AI forecasting models significantly enhances ocean wave behavior prediction accuracy through effective signal decomposition and feature extraction. Subsequently, Majidiyan et al. [4] developed an AI-powered framework that reduces sea-state estimation time lag by transforming temporal/spectral wave features into optimized scalograms, achieving real-time performance through adaptive ship response prediction and deep learning classification.

These technological breakthroughs in marine AI applications fundamentally underscore the critical importance of developing comprehensive, AI-empowered cultivation pathways for naval architecture and ocean engineering education. The pedagogical integration of such advanced methodologies carries immediate practical value by simultaneously addressing three crucial objectives: (1) effectively bridging the growing disparity between academic training and evolving industrial requirements, (2) systematically cultivating students' competencies in implementing cutting-edge AI solutions for complex maritime challenges, and (3) consistently fostering the innovative mindset essential for sustainable ocean engineering development [5]. In-depth research into these educational pathways will enable maritime universities to align their curricula with demonstrated technological capabilities, thereby ensuring graduates possess the sophisticated, future-ready skillset demanded by the modern marine industry's innovation ecosystem.

2 Significance of AI in Cultivating Innovative and Practical Competencies in Maritime Specialty Universities

Artificial intelligence (AI) empowers students in naval architecture and ocean engineering by analyzing complex data (e.g., marine environments, ship design parameters) to reveal hidden patterns and inspire innovative solutions. Ng et al. [6], through their systematic review of 50 AI education studies spanning 2016 to 2022, determined that collaborative project-based learning, with its focus on interdisciplinary problem-solving via concrete artifact creation, represents the most prevalent instructional methodology in the field. Through AI-driven simulations, students explore virtual marine environments, breaking free from traditional thinking and generating creative design approaches.

AI education emphasizes hands-on application, equipping students with skills in programming, algorithm design, and system optimization. Practical projects, such as smart ship simulations and fault diagnosis systems, bridge theory and practice. A controlled study involving 200 randomly assigned students (experimental=101, control=99) evaluated an AI-integrated curriculum's effects using multivariate analysis. Results revealed the experimental group, exposed to combined AI, Machine Learning, and Big Data instruction, demonstrated statistically superior performance in learning satisfaction, problem-solving skills, and continued learning interest compared to controls [7].

As AI transforms naval architecture and ocean engineering, graduates with AI expertise gain a competitive edge. Proficiency in AI-aided design, automation, and fault diagnosis aligns with industry demand, enabling roles in optimized ship design, intelligent manufacturing, and equipment maintenance. This specialization expands career opportunities and positions graduates for higher salaries and advanced career trajectories, meeting the evolving needs of maritime enterprises.

3 AI-Empowered Cultivation Pathways for Innovative and Practical Competencies in Naval Architecture and Ocean Engineering Specialty Universities

3.1 Developing an AI-Integrated Curriculum System

Foundational Theory Module.

This module establishes a systematic AI foundational competency framework to equip naval architecture and ocean engineering students with core knowledge for innovative practice. The curriculum first focuses on fundamental AI principles, covering the complete knowledge spectrum from historical development to cutting-edge applications, with particular emphasis on cultivating methodological capabilities in knowledge representation, logical reasoning, and intelligent search. It then strengthens the application of machine learning algorithms through in-depth analysis and optimization training of typical classification, regression, and clustering algorithms, enabling students to master model selection and parameter tuning skills for various scenarios. Finally, it builds a comprehensive data processing competency chain - starting from raw data collection and cleaning, progressing through statistical analysis to intelligent algorithm application, ultimately developing technology capabilities to solve practical ship and ocean engineering problems through data-driven approaches [8]. Komatina et al. [9] effectively integrated AI with sustainability principles in architectural education across Serbia, Montenegro, and other Western Balkan nations by establishing specialized AI training initiatives that comprehensively addressed both theoretical foundations and hands-on implementation [9]. The module particularly emphasizes the organic integration of theoretical methods and engineering practice, with all instructional content delivered through typical maritime case studies to ensure students acquire directly transferable AI application skills in their professional domain.

Core Discipline Module.

This module systematically embeds AI technologies into core professional competencies through three key dimensions: (1) Intelligent design methodology incorporating evolutionary algorithms for performance optimization and parametric design workflows merging computational fluid dynamics with machine learning; (2) Structural analysis enhancement through hybrid simulation platforms combining finite element analysis with predictive algorithms and intelligent parameter optimization systems; (3) Power system intelligence featuring adaptive control laboratories, real-time condition monitoring systems, and digital twin platforms for marine applications. The implementation adopts modular learning units with progressive AI integration, discipline-specific toolkits with maritime engineering interfaces, and benchmark datasets from industry partners, while incorporating classification society standards for algorithm validation and actual vessel operation data for case development. Through partnerships with marine equipment manufacturers for hardware-in-loop testing and alignment with smart shipping technology roadmaps, this pathway cultivates AI-augmented problem-solving skills, cross-disciplinary integration capability, industry-ready technical competencies, and continuous learning adaptability via a spiral curriculum design that reinforces AI applications across professional contexts while maintaining strong disciplinary foundations.

3.2 Establishing an AI-Powered Platform

To cultivate applied AI competencies in naval architecture and ocean engineering, universities should establish a comprehensive practice platform that integrates both on-campus and off-campus resources. The platform combines advanced AI laboratory facilities with industry partnerships to create an immersive learning ecosystem. On campus, the platform features cutting-edge experimental equipment including intelligent ship simulation environments and marine engineering monitoring systems, supported by professional software tools for AI development and data analysis. These facilities enable students to engage in complete project cycles from AI-driven control system design to performance optimization testing.

The platform's distinctive "virtual-physical integration and project-driven" pedagogy provides authentic learning experiences through two interconnected components. The intelligent ship experimentation module allows students to develop and debug AI algorithms for vessel operations in simulated maritime environments, while the marine engineering monitoring system facilitates hands-on practice in equipment data processing and machine learning-based fault diagnosis [10,11]. For the marine engineering intelligent monitoring component, students participate in complete system development cycles including: operational equipment data acquisition and processing, machine learning/deep learning-based fault diagnosis modeling, and intelligent monitoring system development with optimization testing [12]. Beyond campus, strategic collaborations with industry partners offer students opportunities to apply these AI technologies in real-world ship design and manufacturing processes, exposing them to current industry standards and challenges.

By implementing this integrated approach, the platform effectively bridges theoretical knowledge with practical applications. Students develop not only technical skills in AI system implementation but also critical problem-solving abilities for complex marine engineering scenarios. The emphasis on simulation-based testing and performance optimization exercises ensures graduates acquire the competencies needed to address actual challenges in smart shipping and marine technology development. This practice-oriented model ultimately prepares students to become proficient in applying AI solutions across various naval architecture and ocean engineering contexts.

The innovation platform extends beyond campus through strategic industry collaborations that provide project-based learning opportunities in ship design, manufacturing, and commissioning processes. Corporate partnerships offer access to real working environments where students can apply AI techniques to optimize production processes and equipment maintenance. To foster innovation, the platform incorporates entrepreneurship competitions and incubation services, enabling students to transform AI solutions into viable products. This end-to-end ecosystem systematically develops students' technical competencies in AI applications while cultivating essential innovation and project management skills through authentic engineering scenarios.

3.3 Innovative Teaching Methods

Project-based Learning.

Using project-based learning methods can allow students to enhance their comprehensive abilities through practical operations. Teachers can select practical projects related to naval architecture and ocean engineering as well as artificial intelligence for students to participate in groups. Alexiou et al. [13] demonstrated that machine learning-based regression algorithms, when combined with proper processing of measured parameters grounded in fundamental naval architecture principles, can yield highly accurate predictions of ship operational parameters. This approach can be effectively applied in educational contexts—for instance, when designing an intelligent ocean monitoring buoy project, students are required to integrate their knowledge of naval architecture and ocean engineering to develop the buoy's structure while simultaneously employing artificial intelligence technologies to collect, analyze, and transmit ocean environmental data.

This learning method cultivates students' teamwork ability, as each member in the project has different professional skills and knowledge backgrounds, requiring mutual cooperation and support. At the same time, it also hones students' problem-solving skills and innovation ability. When facing technical challenges or design bottlenecks, students need to find solutions through searching for information, group discussions, etc., in order to stimulate innovative thinking. Zheng et al. [14] developed an AI-enabled feedback and feedforward system and evaluated its effectiveness through a controlled study with 153 participants across three experimental conditions. Their results demonstrated that this approach significantly enhanced collaborative knowledge construction, promoted co-regulated learning behaviors, and improved overall group performance compared to conventional methods.

Blended Learning.

The integration of traditional classroom instruction with online learning platforms establishes an effective blended learning model that capitalizes on the strengths of both approaches. In face-to-face classroom settings, instructors deliver structured knowledge frameworks, and analyze core conceptual challenges. This pedagogical synergy is exemplified in AI-driven ship detection education through Bhattacharjee et al.'s [15] Ship-Net (S-Net) architecture - an optimized deep learning model that achieves 94.88% precision and 79.68% recall in SAR-based vessel identification while reducing computational overhead by 35% compared to traditional methods like Faster RCNN. Beyond developing specialized SAR image processing skills, this case study cultivates essential competencies in computational problem-solving and adaptive AI system design.

At the same time, teachers can use online teaching platforms to collect students' learning data, understand their learning situations and existing problems, in order to provide targeted guidance and explanations in classroom teaching. The blended learning model fully leverages the advantages of traditional classroom teaching and online teaching, improving teaching efficiency and quality, providing students with a more quality learning experience.

4 Conclusion

The rapid development of artificial intelligence technology has brought new opportunities and challenges to the cultivation of innovative practical abilities of students in characteristic maritime engineering universities. By constructing a curriculum system integrating artificial intelligence, building a practical platform for artificial intelligence, and innovating teaching methods, students' innovative practical abilities can be effectively enhanced, and high-quality professional talent adaptable to the needs of industry development can be cultivated. Characteristic naval architecture and ocean engineering universities are actively enhancing students' innovative practical abilities through AI-enabled approaches, while strengthening industry-academia-research integration. Through continuous efforts and innovation, greater contributions should be made to the innovative development in the field of naval architecture and ocean engineering, cultivating more outstanding talents with innovative spirit and practical ability to meet the needs of technological progress and industry transformation.

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