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Big Data Talent Cultivation through Industry–Academia–Research Integration

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Abstract

The big data industry, as a national strategic emerging sector and a key development direction in the Yangtze River Delta region, is driving the digital transformation and intelligent upgrading of the economy and society. The smart shipping industry plays a crucial role in the strategy of building China into a strong transportation power. By leveraging big data, artificial intelligence, cloud computing, and the Internet of Things, it enables applications such as vessel scheduling optimization, port resource allocation, and pollution monitoring and management, making it one of the most promising fields for the integration of big data technologies. However, higher vocational education faces challenges in meeting the demand for big data talents in smart shipping, including insufficient practical capabilities of teachers, outdated teaching philosophies, and misalignment between curricula and job requirements. To address these issues, the program relies on provincial engineering research centers and high-level specialty cluster construction, and explores a talent cultivation model characterized by "platform as the foundation, projects as the core, and integration as the essence." Through the establishment of resource transformation mechanisms, faculty development pathways, and the reconstruction of cross-disciplinary curricula, this model achieves resonance between research, teaching, and industry. Ultimately, it forms a multi-level teaching approach driven by task orientation and research–teaching–application integration, providing a systematic paradigm for talent cultivation to support the deep integration of big data and the shipping industry.

Keywords

Vocational education; Industry–Academia–Research integration; Big data technology; Maritime industry; Project-based approach.

1. Introduction

Under the guidance of the Digital China strategy, the big data industry has increasingly penetrated various fields of economic and social development, becoming a core driver of industrial digital transformation and intelligent upgrading [1-2]. Characterized by the continuous emergence of new technologies and the rapid expansion of application scenarios, the big data industry has generated a large number of new job opportunities and diversified talent demands. However, with the rapid pace of industrial development and the accelerating cycle of technological iteration, talent cultivation models in higher education—particularly in vocational colleges—struggle to adapt to these changes in a timely manner. This misalignment between curricula and job requirements ultimately affects both the quality and efficiency of talent supply [3].

The smart shipping industry represents an important direction in the strategy of building China into a strong transportation power [4]. At its core, it leverages emerging technologies such as

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big data, artificial intelligence, cloud computing, and the Internet of Things to drive the intelligent upgrading of the shipping sector. The applications of big data technology in smart shipping are extensive: on the one hand, the integration and analysis of multi-source data—including vessel trajectories, meteorological and oceanographic conditions, and freight logistics—enable intelligent navigation scheduling, route optimization, and safety early warning. On the other hand, big data empowers the construction of smart ports by providing decision support in areas such as port resource allocation, ship–shore collaborative scheduling, and pollution monitoring and management. With the continuous development of the industry, smart shipping has become not only a key engine for the transformation and upgrading of traditional shipping but also one of the most promising application fields for big data technologies [5]. This cross-disciplinary integration has intensified the urgent demand for big data professionals, requiring them to possess both solid data analysis capabilities and the ability to understand and address complex problems in the maritime domain.

The high-quality development of the smart shipping industry imposes higher requirements on students majoring in big data technology at vocational colleges. First, as job demands become increasingly diversified, students are expected not only to master general skills such as data collection, cleaning, storage, analysis, mining, and visualization, but also to acquire professional knowledge of the shipping domain and cross-disciplinary application capabilities [6]. Second, with the growing complexity of smart shipping systems, the industry urgently requires compound talents who are capable of project-based development, interdisciplinary collaboration, and innovative thinking. However, significant challenges remain in current vocational education: teachers generally lack sufficient professional practice experience, and teaching philosophies remain oriented toward traditional knowledge transmission, making it difficult to support project-based teaching reform under the integration of industry, education, and research. Moreover, evident misalignments persist between curricula and job requirements, preventing effective personalization and specialization in student training. These issues have constrained the deep integration of the smart shipping and big data industries, underscoring the urgent need to reform and optimize the talent cultivation model.

2. Talent Cultivation Model for Maritime Big Data

To implement the strategic requirements of smart shipping under the national plan for building China into a strong transportation power, it is necessary to address three pressing challenges in the cultivation of smart shipping information talents: (1) the significant gap between curricula and job requirements, (2) the insufficient practical competence of teachers, and (3) the difficulty in achieving personalized and specialized student training. As illustrated in Figure 1, the big data technology program has established a talent cultivation model for smart shipping information disciplines, characterized by the principle of “platform as the foundation, projects as the core, and integration as the essence.” This model makes full use of resources from industry, academia, and research to construct a collaborative innovation platform for smart shipping, with shipping informatization projects serving as the driving force to actively explore and practice the integrated cultivation of “shipping + big data” talents.

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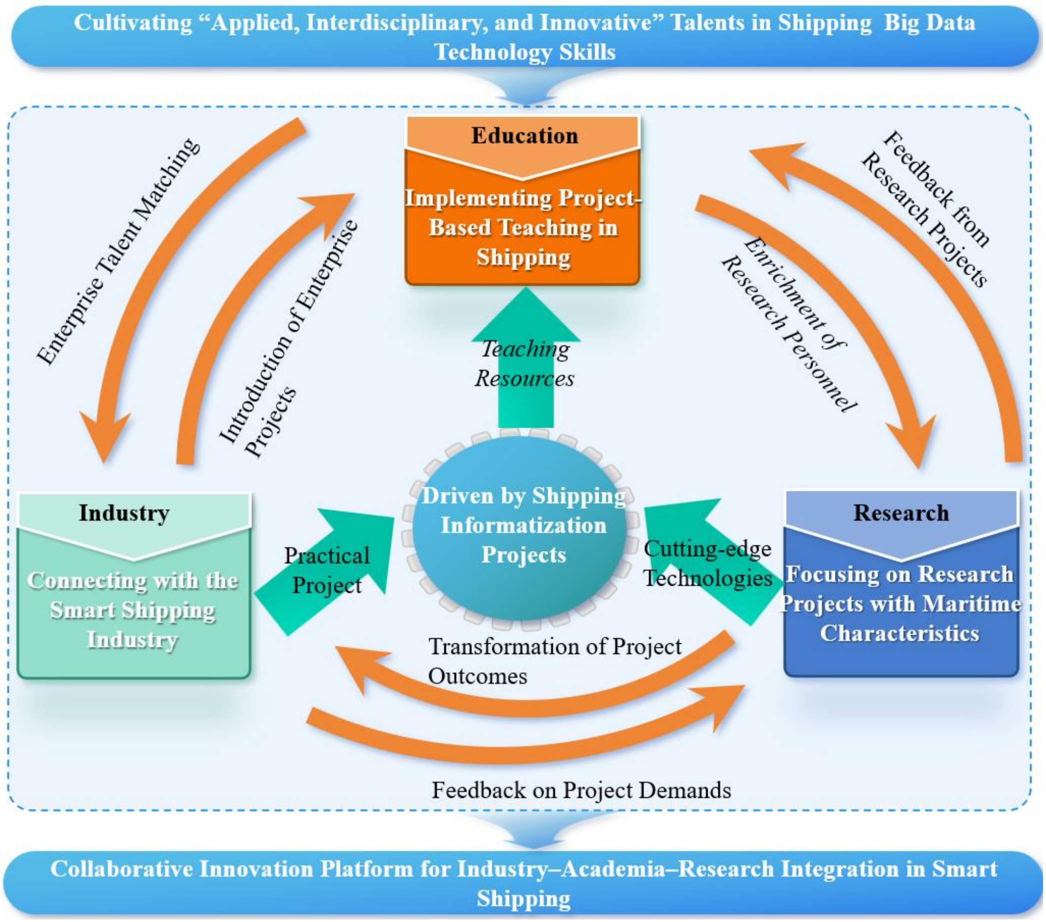

Figure 1. The talent cultivation model for maritime big data

2.1. Building a New Paradigm for Resource Transformation Aligned with Industry Frontiers

As illustrated in Figure 2, the program relies on a school–enterprise collaborative mechanism and a multi-dimensional team-based evaluation system to efficiently advance the transformation of resources for industry–academia–research integration. With cases, documents, codes, data, specifications, and standards serving as input elements, the transformation of educational resources is effectively promoted. Projects are obtained through the school–enterprise collaboration mechanism and enterprise practice, enabling the program to align with real-world industrial projects and providing the source for resource transformation. Project modification focuses on teaching adaptability, in which industrial projects are adjusted and their core elements extracted, integrating industry frontiers with educational logic. Projects are further decomposed from multiple dimensions, transforming industrial scenarios into modular teaching content. The multi-dimensional team-based evaluation system ensures the quality of resource transformation. During the case and task decomposition process, enterprise representatives, internal faculty, and course leaders jointly participate to eliminate cognitive bias. In skill mapping, projects are translated into courses and cases, embedding industry core competencies. During the resource development stage, course teams work collaboratively to iteratively develop teaching cases and build resource platforms.

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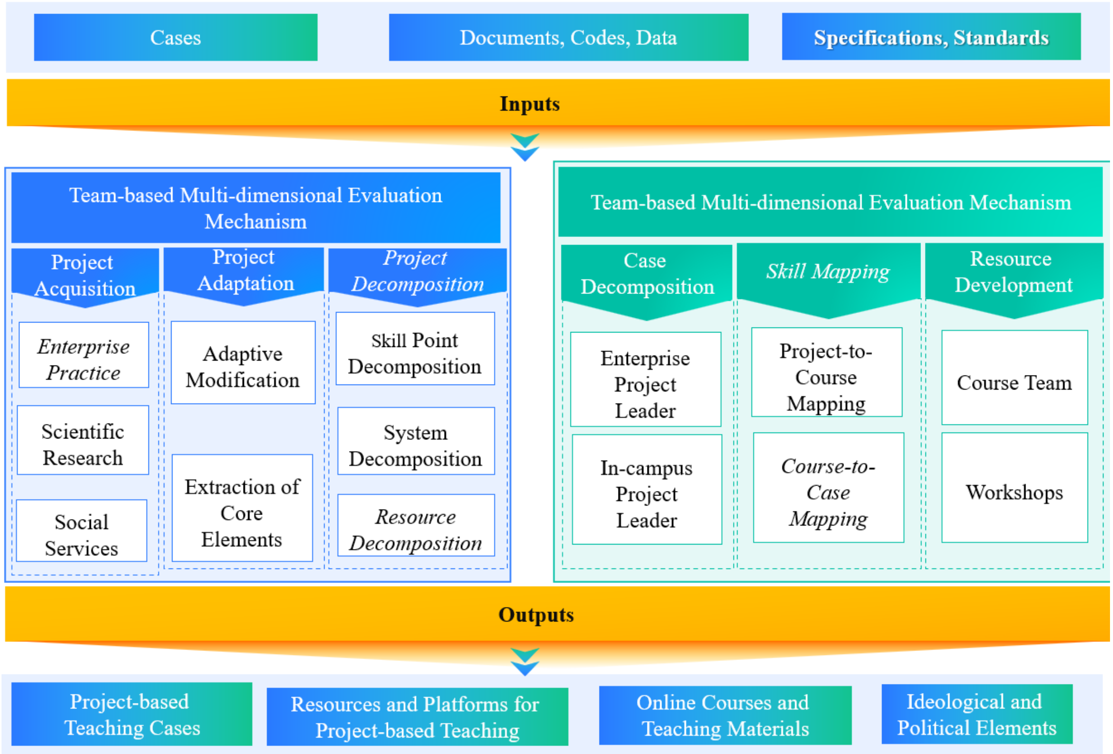

Figure 2. The resource transformation mechanism for industry–academia–research integration

The primary task of maritime project-based teaching is to define clear talent cultivation objectives, ensuring that the curriculum system aligns closely with the demands of the smart shipping industry. As shown in Figure 1, course objectives should be grounded in the national "Maritime Power" strategy, while balancing professional skills, vocational competencies, and value-driven education.

2.2. Resource Transformation Mechanism for Industry–Academia–Research Integration

A "multi-dimensional, resource-converging" platform cluster for industry–academia–research integration has been established, pooling resources, faculty, and industrial projects to provide teachers with localized carriers for teaching and research. This approach aims to address the misalignment between faculty competencies and industrial development.

An integrated resource platform has been established to support the alignment of faculty development with industrial needs. This platform breaks down barriers between university research computing power, enterprise production data, and vocational training resources, enabling the sharing of computational resources and data from smart shipping. Centered on the Engineering Research Center and the Jiangsu Province High-level Specialty Cluster, and in collaboration with enterprises such as Nanjing Huihai, the program integrates teaching and research projects as well as industry standards, thereby jointly developing teaching resource repositories and conducting research on virtual simulation resources.

Focusing on the core competencies of "industry capability, research capability, and teaching capability," the program has built cross-departmental, cross-disciplinary, and cross-industry innovation teams to cultivate a "three-capability" faculty team, driving teachers to remain in resonance with industry development. By breaking down barriers between research, teaching, and social service workloads, and by establishing clear standards for transformation, the program encourages teachers to deeply engage with industry in their areas of expertise.

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In addition, a pathway has been established to enhance teachers' practical abilities, ensuring their alignment with industrial development. A dual-context practice system of "enterprise–college" has been constructed, supported by a residency plan known as the "Three Engagements"—engaging with enterprises, engaging with projects, and engaging with workshops. Engagement with enterprises involves all faculty members participating in enterprise practice to synchronize with technological iterations. Engagement with projects guides faculty to undertake major natural science projects in provincial universities, thereby improving their capacity to adapt to industrial demands through technical problem-solving. Engagement with workshops enables faculty to decompose enterprise projects into teaching and training tasks, thereby achieving a two-way transformation between industrial projects and teaching practices.

2.3. Reconstructing a Project-Based Curriculum System for Cross-Disciplinary Integration

The program has reconstructed a project-based curriculum system with maritime characteristics, characterized by "shared foundation at the basic level, modular development at the intermediate level, and directional specialization at the advanced level." This system dismantles tasks to bridge knowledge gaps, reshapes the competence chain through hierarchical structures, and activates team innovation via institutionalized collaboration. Taking project-based learning as the carrier and competence output as the orientation, the system closely aligns with industrial needs and enhances students' ability to integrate knowledge across disciplines.

To meet the workforce demands in smart shipping—including intelligent vessels, smart ports, smart navigation safety, smart shipping services, and smart supervision—the program uses production-oriented projects in "Big Data + Shipping" as well as faculty research projects as the sources. Following educational principles, the program decomposes the "system–scenario–task" chain step by step and maps it onto courses, thereby addressing the fragmentation of knowledge systems in traditional cross-disciplinary teaching. Projects such as the Yangtze River Vessel Water Pollution Joint Supervision System, Vessel Shore Power Intelligent Application System, and Vessel Intelligent Monitoring and Command Platform are adopted as mother projects and further broken down into interdisciplinary tasks: for example, Machine Learning focuses on vessel trajectory clustering and anomaly detection; IoT Technology and Applications designs multi-source data acquisition and edge gateway access in engine rooms; Data Engineering undertakes modeling and quality validation for vessel trajectory data lakehouse integration; Web Front-end Design develops scheduling and energy-efficiency dashboards; and Cloud Native and DevOps is responsible for containerized deployment, CI/CD, and observability integration of the Yangtze River vessel water pollution supervision system. Each task is accompanied by a "five-piece package"—task description, dataset, evaluation rubric, case template, and competence profile—specifying business objectives, interfaces and data contracts, KPIs, and assessment methods.

The program has also developed a layered pathway for curriculum construction in information disciplines with maritime characteristics, based on "micro-level embedded scenarios, meso-level task integration, and macro-level industry orientation." This approach addresses the problems of fragmented cross-disciplinary knowledge systems, weak cross-domain transfer, and insufficient teamwork capabilities, while ensuring that curriculum construction remains in resonance with industrial frontiers through institutionalized industry–academia–research collaboration. At the micro level, maritime scenarios are embedded into general and core courses, restructuring course units around teaching contexts. At the meso level, an "big data technology+ shipping" curriculum cluster is designed, organized around projects that follow the layered model of "foundation–module–direction," forming a competence chain for

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cultivating composite talents with "information + shipping" expertise. Interdisciplinary workshops and elective project classes further enhance students' ability to solve real-world industrial problems. At the macro level, a dual-line collaborative mechanism is established, integrating high-level specialty clusters with provincial engineering research centers. Through initiatives such as "enterprise within university" (Smart Shipping Industry Academy), "university within enterprise", and "university on ship", as well as through joint research projects and graduation projects, the program realizes the integration of education, research, and industry.

As illustrated in Figure 3, a coordinated linkage of "in-class, extracurricular, and school–enterprise" activities has been formed, with the full process of shipping projects as the central thread. This constructs a closed-loop talent cultivation pathway encompassing knowledge transfer, skill practice, and industrial application, fostering students into project-oriented professionals who meet the developmental needs of the shipping industry. In-class teaching emphasizes the full lifecycle of smart shipping projects, progressively refined into three levels of competence training: "strengthening foundations, fostering individual development, and enabling diversified directions." Using the "integrated workshop" as a carrier, the program integrates scientific research, skill competitions, and social services, thereby enhancing students' practical abilities through multiple pathways. Through the school–enterprise collaborative training model, the program connects internal and external resources to undertake enterprise projects and promote the intelligent transformation of the Yuxin Vessel, achieving seamless integration between learning and application.

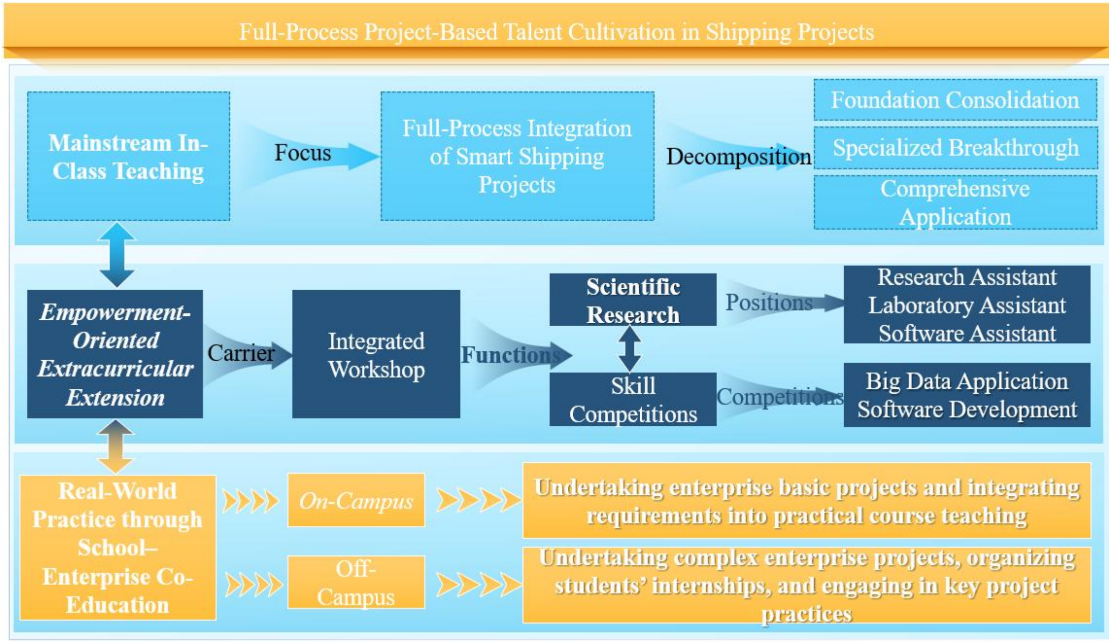

Figure 3. The project-based talent cultivation process embedded in the full lifecycle of shipping projects

3. Characteristics of the Talent Cultivation Model

The program actively engages with the national strategy of building China into a strong maritime power, aligning precisely with the developmental needs of the smart shipping industry. With platforms as the foundation and projects as the linkage, it has explored new pathways for industry–academia–research integration, promoting the flow, aggregation, and integration of resources across science, industry, and education, and has achieved remarkable results.

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3.1. Research–Teaching–Application Synergy Mechanism for Industry–Academia–Research Integration

To achieve resonance across research, teaching, and industry, the program has established a research–teaching–application synergy mechanism that drives the implementation of integration through institutional innovation. A Committee for Science–Education Integration and Industry–Education Collaboration has been established to implement a "problem proposed by enterprise – project initiated by the college – joint solution – demonstration and transformation – scaled replication" model, with project managers and milestone assessments. Key indicators such as the proportion of research outcomes integrated into teaching, the coverage of project-based courses, and completion timelines are included in the evaluation system, ensuring that research results are rapidly incorporated into classrooms and serve industry needs.

An integrated workshop has also been created as a carrier of industry–academia–research integration, integrating the functions of scientific research, skill competitions, and social services, thereby enhancing students' comprehensive abilities through diverse practices. Through a school–enterprise co-education model, the program leverages smart shipping projects and the intelligent transformation of the Yuxin Vessel to achieve seamless integration of learning and application. This synergy mechanism empowers R&D, education, and industrial upgrading with precision, enhancing the overall coordination, competitiveness, and innovation capacity of industry–academia–research integration, thereby providing strong support for cultivating shipping-oriented information talents and promoting the high-quality development of the smart shipping industry.

3.2. Triadic Co-Evolutionary Innovation Model for Industry–Academia–Research Integration

Taking field theory as its perspective and cross-disciplinary integration as its foundation, the program has built an innovative model that fuses research, education, and industry. This model breaks down the boundaries between the three fields, achieving deep integration of education, research, and production. It forms a project-driven, industry-oriented innovation model for industry–academia–research integration, with talent cultivation as the core.

Relying on the Smart Shipping Industry–Academia–Research Collaborative Innovation Platform, the program advances "dual-line integration" between research and technology service platforms such as the Provincial Engineering Research Center, and teaching platforms such as the Provincial High-Level Specialty Cluster. This enables joint construction of R&D platforms, sharing of computing resources, and co-utilization of data resources, thus building a new ecosystem for coordinated resource utilization.

The program integrates provincial and higher-level research and teaching teams, building a composite faculty team characterized by "understanding maritime operations, mastering information technology, and conducting smart research." Teachers are thus transformed from "knowledge transmitters" into "co-innovators in industry–academia–research," strengthening their capacity to serve industry and participate in research. Using projects as the key linkage, the program connects with real industrial and research needs, extracts project core elements, and translates them into modular teaching content. This establishes a new paradigm for resource transformation aligned with industry frontiers, comprehensively improving both talent cultivation quality and industrial adaptability.

3.3. Task-Driven and Hierarchically Progressive Pathways for Industry–Academia–Research Integration

The program introduces new technologies, standards, and applications in the field of smart shipping, transforming enterprise projects and research topics into teaching cases, thereby connecting the full chain of "system–scenario–task." The teaching system follows a task-driven, hierarchical project-based pathway of "micro-level embedded scenarios, meso-level task integration, and macro-level industry orientation."

At the micro level, projects are used to embed abstract knowledge into specific contexts, addressing the problem of students "learning without application." At the meso level, course tasks are vertically integrated to form a competence chain of "shared foundation – modular development – directional specialization," thereby avoiding fragmentation across disciplines. At the macro level, teaching, research, and industry are interconnected, promoting school–enterprise co-education, joint research, and joint graduation projects, thus aligning knowledge systems, competence development, and industrial needs.

The instructional design closely aligns with the five key elements of smart shipping: intelligent vessels, smart ports, smart navigation safety, smart shipping services, and smart supervision. Projects such as the Yangtze River Vessel Water Pollution Joint Supervision System, Vessel Shore Power Intelligent Application System, and Vessel Intelligent Monitoring and Command Platform are decomposed into interdisciplinary tasks, including vessel trajectory clustering and anomaly detection (Machine Learning), multi-source engine-room data acquisition and edge gateway access (IoT Technology and Applications), data lakehouse modeling and quality validation (Data Engineering), scheduling and energy-efficiency dashboard visualization (Web Front-End Design), and containerized deployment, CI/CD, and observability integration (Cloud Native and DevOps). These tasks cover the full spectrum of smart shipping applications.

4. Conclusion

This study focuses on the cultivation of big data talents under the context of smart shipping and proposes an education reform approach centered on industry–academia–research integration. Through platform development and project-driven initiatives, the model achieves comprehensive innovation in resources, faculty development, and curriculum design, addressing key challenges in vocational education such as insufficient adaptability of talent cultivation, limited opportunities for teacher capacity enhancement, and inadequate cross-disciplinary integration. The findings indicate that this model effectively promotes the linkage of research, teaching, and industry, advancing the deep integration of education, research, and practice, and establishing a cross-disciplinary, project-based, and application-oriented talent cultivation pathway. The model not only supports the high-quality development of the smart shipping industry but also provides a transferable paradigm for non-information disciplines to develop information-related programs, demonstrating strong exemplary and replicable value.

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References

[1] Liu, Lizhi. "The rise of data politics: Digital China and the world." *Studies in Comparative* International Development 56.1 (2021): 45-67.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0042

[2] Cheng, Yulong, and Dzhedzhula Viacheslav. "Teaching Reform of “Course Competition Integration” in Engineering Cost Major Based on Vocational Skills Competition explore and practice." 2025 4th International Conference on Humanities, Wisdom Education and Service Management (HWESM 2025). Atlantis Press, 2025: 312-321.

[3] Esmail, Abdel Hamid MS, and Zahid M. Khan. "Alignment of vocational education curricula with job requirements in industrial sector: Analysis study." World Journal of Advanced Research and Reviews 21.3 (2024): 2303-2313.

[4] Ahn, Young-Gyun, et al. "A study on the development priority of smart shipping items—Focusing on the expert survey." Sustainability 14.11 (2022): 6892.

[5] Xiao, Yi, Zhuo Chen, and Levi McNeil. "Digital empowerment for shipping development: A framework for establishing a smart shipping index system." Maritime Policy & Management 49.6 (2022): 850-863.

[6] Lv, Taizhi, Juan Zhang, and Enze Wu. "Research and Practice on the Integrative Teaching Model of" Post-Course-Competition-Certificate-Research" for Big Data Technology Major." International Journal of New Developments in Education 6.6 (2024): 220-225.