International Core Journal of Social Sciences
ISSN: 3080-8774 (Print), ISSN: 3080-8782 (Online) | Vol. 2, No. 2, 2026

A Practice-Based Study of Research Projects Supporting Student Development in Higher Vocational Big Data Technology Education

Juan Zhang, Taizhi Lv

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

Abstract: To address outdated teaching content, weak links between practical tasks and industry contexts, and the limited conversion of research resources into educational resources in higher vocational Big Data Technology programmes, this study examines implementation pathways through the Jiangsu Provincial Natural Science Research Project for Higher Education Institutions, "Research on Waterway Traffic Characteristics Based on AIS Data." Drawing on the project's operational requirements and implementation process, maritime operational problems, data processing methods, platform development experience, and research practices are adapted for teaching and translated into teaching cases, competition training projects, graduation design projects, materials for curriculum-based ideological and political education, and textbook resources. These pathways form a practical framework linking research tasks with multiple educational settings. The study suggests that effective research-informed teaching requires an appropriate scope of adaptation based on occupational competencies and students' prior knowledge, progressively structured tasks that preserve engineering logic, reproducible outputs for assessing learning, and sustained implementation through team collaboration and textbook resource development. The practice offers a reference for integrating research and education in higher vocational programmes with an industry focus.

Keywords: Integration of Research and Education; Research-Informed Teaching; Big Data Technology; AIS data.

1. Introduction

The integration of research and education is an important means of connecting technological innovation with the development of technical and vocational skills. The Opinions on Deepening Reform of the Modern Vocational Education System identify this integration as a new direction for reform and emphasise collaborative innovation across vocational, higher, and continuing education to improve the responsiveness of education to economic and social development [1]. The Master Plan on Building China into a Leading Country in Education (2024–2035) further calls for coordinated development of education, science and technology, and talent, stronger institutional capabilities in vocational schools, and mutually reinforcing development between vocational education and industry [2]. For higher vocational colleges, implementing this integration requires incorporating the problems, methods, data, and engineering experience generated through research into teaching. Students should understand the rationale for technical choices while acquiring operational skills and developing the ability to analyse problems, validate solutions, and improve their work.

Previous studies have examined the integration of research and vocational education in terms of research orientation, organisational mechanisms, and resource allocation. Hao argues that higher vocational colleges should adopt an application-oriented research approach and promote changes in research paradigms by applying research outcomes in teaching and industry and strengthening research infrastructure [3]. From the perspective of vocational education development, Tao identifies the separation of teaching from research, uneven resource allocation, and insufficient institutional support as constraints, highlighting the need to improve research governance and evaluation mechanisms [4]. These studies suggest that the educational value of research in vocational colleges depends both on its relevance to industry needs and on whether research processes can be incorporated into courses and student practice. Focusing specifically on research-informed teaching, Dai et al. use a questionnaire survey of vocational college teachers to examine barriers to applying research outcomes and propose improved evaluation systems and stronger teams of teachers with both teaching and industry expertise [5]. Although these studies offer insights into institutional support and teacher development, programme-level implementation still needs to address how a single research project can generate tasks for different learning stages, how research methods can become skills that students can master, and how courses, competitions, and graduation design projects can share resources.

The Teaching Standards for the Big Data Technology Programme (Higher Vocational Education at the Junior College Level) identify big data implementation and operations, data collection and processing, data analysis and visualisation, and big data platform management as major occupational areas. They also specify competencies in data cleaning, analytics and mining, visual communication, and platform deployment and operations [6]. These competencies closely align with the collection, processing, storage, analysis, and application of maritime data. The Automatic Identification System (AIS) continuously generates large volumes of data with strong spatiotemporal relationships and complex data quality issues, providing a practical subject that can span several courses. Through sustained programme development, the college has established an educational model integrating occupational requirements, courses, competitions, certifications, and research, with projects extending across the entire learning process. Occupational needs inform course design, while competition training methods, occupational certification requirements, and

teachers' research projects are incorporated into courses. This provides a foundation in which courses are derived from occupational tasks, enriched by research, strengthened through competitions, and assessed against certification requirements. The programme selects the Jiangsu Provincial Natural Science Research Project for Higher Education Institutions, "Research on Waterway Traffic Characteristics Based on AIS Data," as a case. The project examines large-scale AIS data storage, real-time processing, waterway traffic characteristics, and visualisation, involving stream processing, distributed storage, trajectory queries, and data quality management. AIS data analysis serves as a common thread in teaching, with practice organised around basic, specialised, and integrated skills. Foundational, advanced, and extension tasks support students with different levels of prior knowledge as they progressively complete integrated projects. This foundation embeds research-informed teaching within the established educational framework rather than relying on isolated cases introduced by individual teachers.

2. Applying Research to Student Development

As shown in Figure 1, the framework draws on a provincial engineering research centre, a maritime-focused teaching team, and college–enterprise collaboration. Using the AIS research project as a vehicle, research resources are adapted into cross-course teaching cases, competition training projects, graduation design projects, materials for curriculum-based ideological and political education, and textbook resources through occupational competency mapping, task selection, data de-identification, and differentiated task difficulty. These pathways develop students' technical skills, engineering judgement, inquiry skills, and professional attributes. Courses and resources are continuously revised in response to student task performance, process records, and industry feedback.

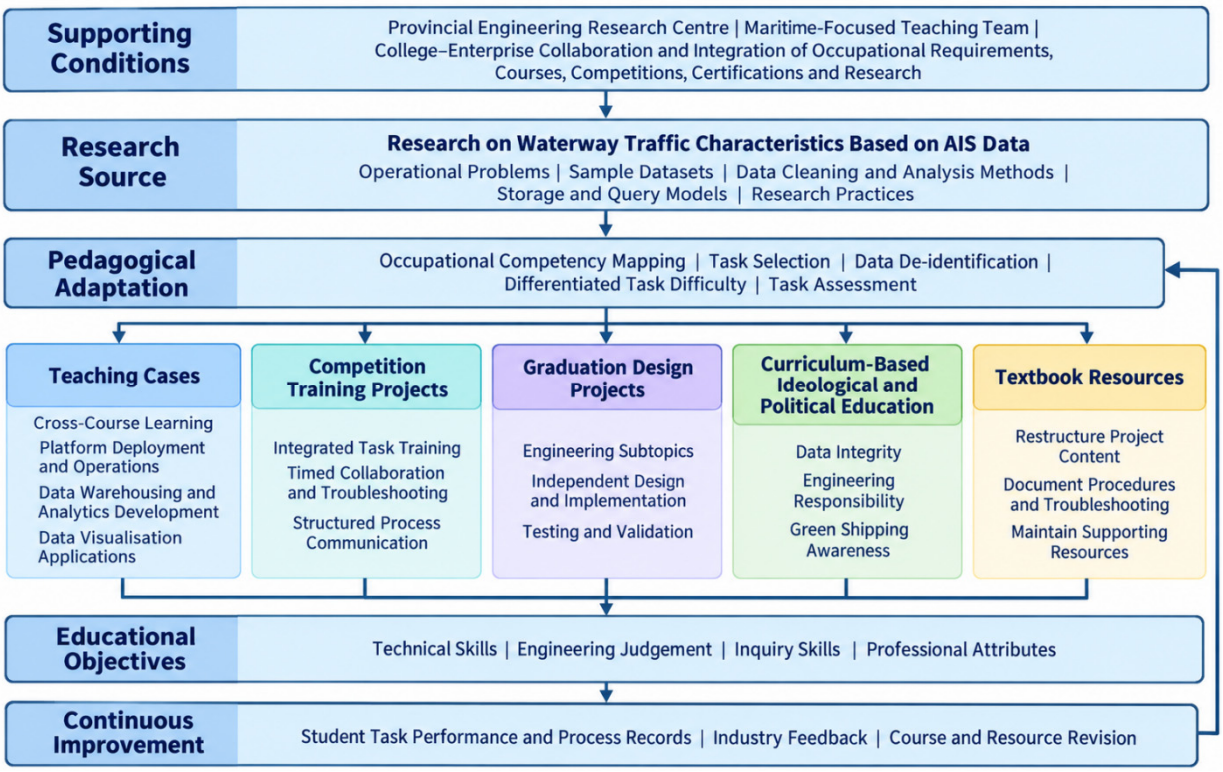


Figure 1. Framework for research projects supporting student development in the Big Data Technology programme

2.1. Adapting Research Cases into Teaching Cases

Drawing on "Research on Waterway Traffic Characteristics Based on AIS Data," tasks involving navigation data storage, processing, analysis, and presentation are reorganised into a teaching case entitled "Vessel Navigation Data Analysis Platform," which spans the programme's core courses. The courses share operational contexts, sample datasets, and project objectives. Connected tasks enable students to build the platform progressively and understand the complete workflow of a big data project.

In Big Data Platform Deployment and Operations, students configure, deploy, and test connectivity between components such as Hadoop, Kafka, Spark, HBase, and Redis to meet AIS data ingestion, storage, and query requirements. Typical faults are used to develop log analysis, fault diagnosis, and backup and recovery skills, while the deployed platform provides an operational environment for subsequent courses. In Data Warehousing Technologies, students design data models around dimensions such as vessel, time, and region. Using Hive, they perform data extraction, cleaning, loading, and layered modelling, standardise field formats, and handle duplicate, missing, and anomalous records to provide consistently defined data for analysis and development. In Big Data Analytics and Development, students use Spark for offline analysis and real-time statistics on vessel counts, speed distributions, and regional traffic volumes. Clustering tasks involving trajectory anomalies and navigation state identification develop skills in data processing, feature construction, method selection, and interpretation. In Data Visualisation Technologies and Applications, students use Vue.js, ECharts, and mapping components to present traffic volume trends, regional vessel distributions, and navigation

trajectories. Time filters, region selection, and linked charts develop skills in API use, interaction design, and visual communication, while students verify that the displayed results follow consistent statistical definitions.

2.2. Adapting Research Cases into Competition Training Projects

Drawing on the rules for the Big Data Application Development event of the Jiangsu Provincial Vocational College Skills Competition, the AIS research project is reorganised into an integrated training project entitled "Vessel Navigation Data Processing and Waterway Traffic Characteristic Analysis." Operational problems, sample datasets, and technical documentation connect research tasks with the competition's skill requirements.

Historical AIS data are extracted, cleaned, organised into layers, and used to calculate indicators with Spark, Hive, and Hudi, developing offline processing and workflow scheduling skills. Features such as speed, heading, and changes in position support clustering, regression, and classification exercises, supplemented by recommendation algorithm training to develop feature engineering and model application skills. Flume, Kafka, and Flink support message collection, parsing, and real-time statistics, while HBase and Redis provide storage, query, and troubleshooting exercises that develop real-time processing skills. Vue.js and ECharts are used to present vessel distributions, traffic volume trends, and navigation characteristics, developing API integration and charting skills. Research documentation is adapted into Milvus retrieval tasks to practise text processing, vector ingestion, and hybrid search. Team-based task allocation, timed integration testing, technical reports, and live presentations embed integrated analysis, standardised operation, collaboration, and communication throughout the training process.

2.3. Adapting Research Cases into Graduation Design Projects

The functional modules of the AIS research project and their extended applications are developed into graduation design topics. Data collection, quality management, trajectory queries, traffic characteristic analysis, and visualisation provide a range of clearly defined projects with appropriate levels of difficulty. By completing individual subprojects, students practise requirements analysis, solution design, programming, system testing, and documentation in an integrated manner.

Topics derived from the project's modules include "Design and Implementation of a Vessel AIS Data Collection and Cleaning System," "Design and Implementation of an HBase-Based Vessel Trajectory Storage and Query System," and "Design and Implementation of a Vessel Traffic Characteristic Analysis System for a Specified Water Area." Adjustments to operational subjects, technical methods, and application approaches extend these topics to abnormal vessel behaviour identification, navigation data quality monitoring, traffic situation visualisation, and intelligent retrieval of maritime technical documents, meeting the training needs of students with different levels of preparation.

The projects share sample datasets, operational rules, and basic computing environments, while individual responsibilities and functional boundaries remain clearly defined. Supervisors incorporate research practices such as problem analysis, comparison of alternative solutions, and validation of results into the design process. Students connect data processing, algorithm application, and system development, improving their engineering practice, independent inquiry, and ability to apply knowledge in an integrated way while addressing specific operational problems.

2.4. Translating Research Attributes into Materials for Curriculum-Based Ideological and Political Education

Research projects offer educational material related to the pursuit of truth, rigorous and meticulous work, collaborative problem-solving, and service to society. Drawing on AIS research practice, researchers' experiences of analysing problems, conducting repeated validation, and overcoming technical difficulties are developed into cases for curriculum-based ideological and political education. These cases help students understand research work while appreciating scientific values, professional character, and responsibility to the industry.

Respect for facts and the pursuit of truth are translated into materials for integrity education. Scenarios involving the verification of anomalous navigation data and analytical results encourage students to base their work on evidence, record procedures accurately, interpret results objectively, and adopt a fact-based approach. Repeated testing and continuous optimisation provide materials for education in craftsmanship. Cases involving troubleshooting and solution refinement cultivate rigour, attention to detail, commitment to quality, and perseverance in the face of difficulties.

Experiences of interdisciplinary collaboration and joint problem-solving are developed into materials for teamwork education, helping students understand the importance of communication, fulfilling responsibilities, and sharing knowledge. Research serving waterway traffic safety, green shipping, and maritime regulation provides materials for cultivating responsibility. Students recognise the connections between technical expertise and human safety, environmental protection, and maritime development, strengthening their commitment to serving the industry and society and integrating professional learning with values education.

2.5. Applying Research Outcomes to the Development of Print–Digital Integrated Textbooks

Ongoing research can provide continuously updated operational cases, technical methods, and practical resources for print–digital integrated textbooks. Taking Big Data Platform Deployment and Operations as an example, platform construction, data ingestion, storage and queries, and operations and maintenance within the AIS project are adapted into textbook tasks. The vessel navigation data analysis platform connects the teaching units, linking explanations of knowledge with engineering practice.

As the research progresses, new operational requirements, technical solutions, and typical problems are incorporated into textbook development. The printed textbook focuses on platform architecture, technical principles, task workflows, and operating procedures. Supporting digital resources provide deployment demonstrations, configuration files, sample datasets, test scripts, and troubleshooting cases. Digital resources allow operating instructions and extension tasks to be updated as components are upgraded,

environments are adapted, and performance is optimised, keeping the textbook aligned with technological development.

An update mechanism links research, textbook writing, and teaching. Methods validated in research are organised into teaching resources, while difficulties encountered in classroom use inform improvements to task design. Through continuing research and iterative textbook revision, research experience is accumulated as accessible, practical, and updatable textbook content that supports independent learning and engineering practice.

3. Conclusion

Using “Research on Waterway Traffic Characteristics Based on AIS Data” as a case, this study explores practical pathways through which research projects support student development in higher vocational Big Data Technology education. Pedagogical adaptation turns research tasks into teaching cases spanning professional courses, integrated training projects aligned with competition requirements, and graduation design topics suited to differences among students. Research attributes become materials for curriculum-based ideological and political education, while continuing research supports updates to print–digital integrated textbooks. These pathways bring operational problems, technical methods, and values arising from research into the educational process.

Research-informed student development requires attention to occupational needs and students' prior knowledge, coordinated planning of course tasks, practical training, and resource development, and effective use of the same project across different educational settings. Further work should strengthen collaboration among teaching teams, research platforms, and enterprises; continuously update cases, project topics, and digital resources as research and technologies advance; and improve teaching design in response to student performance. Such efforts can reinforce the interaction between research and teaching and provide a practical reference for integrating research and education in higher vocational programmes with an industry focus.

Acknowledgments

This work was supported by the funding of the Fundamental Computer Education and Teaching Research Project of the Association of Fundamental Computing Education of Chinese Universities (2025-AFCEC-085), the Research Project on Education and Teaching Reform of Higher Education in Jiangsu Province (Research on the Cultivation Model of Specialized Talents in Maritime Information Empowered by Generative AI, 2025JGZZ12), and the 2026 Excellent Teaching Team of QingLan Project of the Jiangsu Higher Education Institutions of China (Teaching Team for Artificial Intelligence Technology Applications).

References

[1] General Office of the CPC Central Committee, & General Office of the State Council. (2022, December 21). Opinions on deepening reform of the modern vocational education system. Ministry of Education of the People’s Republic of China. https://www.moe.gov.cn/jyb_xxgk/moe_1777/moe_1778/202212/t20221222_1035691.html.

[2] CPC Central Committee, & State Council. (2025, January 19). Master plan on building China into a leading country in education (2024–2035). Ministry of Education of the People’s Republic of China. https://hudong.moe.gov.cn/jyb_xxgk/moe_1777/moe_1778/202501/t20250119_1176193.html.

[3] Hao, T. C. (2023). Research on the renewal of research paradigms in higher vocational colleges in the context of integrating research and education. Chinese Vocational and Technical Education, (6), 11–16.

[4] Tao, S. Q. (2025). Research on the development of research-education integration in vocational education. Journal of Baotou Vocational & Technical College, 26(2), 57–61.

[5] Dai, Y., et al. (2024). Exploring the implementation path of research achievements backfeeding education and teaching in higher vocational colleges under the background of science and education integration. The Theory and Practice of Innovation and Entrepreneurship, 7(21), 80–82, 86.

[6] Ministry of Education. (2025). Teaching standards for the big data technology programme (higher vocational education at the junior college level). https://www.moe.gov.cn/s78/A07/zcs_ztzl/2017_zt06/17zt06_bznr/bznr_zyjyzyjxbz/gdzyjy_zk/zk_dzyxxdl/dzxxdl_jsjl/202502/P020250207532993683513.pdf.

[7] Ministry of Education. (2020, May 28). Guidelines for developing curriculum-based ideological and political education in higher education. Ministry of Education of the People’s Republic of China. https://www.moe.gov.cn/srcsite/A08/s7056/202006/t20200603_462437.html.