Project-Based Teaching Reform of "Big Data Platform Deployment and Operation" from the Perspective of Curriculum Ideology and Politics

Enze Wu, Taizhi Lv

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

Abstract

Driven by the demands of smart shipping and the comprehensive promotion of Curriculum Ideology and Politics (CIP), this study addresses the challenges in cultivating big data professionals, such as the disconnection between professional training and value education. Relying on the core course Big Data Platform Deployment and Operation, the study constructs a reform framework centered on the authentic project "Big Data–Assisted Risk Analysis for Waterway Construction." A comprehensive scheme incorporating the "IDEAL" project-based teaching model, granular digital resources, and value-added assessment is implemented. Supported by a digital-twin waterway system and AI-based supervision, this reform enables precise teaching feedback. Practice indicates that the approach effectively improves students' competencies in data modeling and visualization while enhancing their professional ethics and engineering thinking. It offers a replicable paradigm for integrating CIP with project-based learning in vocational institutions.

Keywords

Curriculum ideology and politics, Project-based teaching, Big Data Platform Deployment and Operation, smart waterways, vocational education.

1. Research Background and Problem Statement

The Ministry of Transport of China, in its *Opinions on Accelerating the Construction of Smart Ports and Smart Waterways*, proposes that by 2027 a number of world-class smart ports and smart waterways should be established to promote the digital transformation and upgrading of the shipping industry. The emerging smart shipping ecosystem demands compound skilled personnel who not only understand shipping business processes, but also master technologies such as big data platforms, stream processing, and distributed storage [1-2].

As a core course in the Big Data Technology program, *Big Data Platform Deployment and Operation* undertakes the task of cultivating key competencies in cluster deployment, data collection, data analysis, and visualization. At the same time, it must meet both industry standards and the competency requirements of certifications such as HCIA for Big Data How to consolidate students' big data technology foundations within limited class hours, while guiding them to develop a data ethics perspective and professional responsibility aligned with the national strategies of building a strong transportation country and a strong maritime country, has become a central issue in course reform.

In recent years, curriculum ideology and politics has become a research hotspot in higher vocational education [3]. Existing studies mainly focus on teaching design, construction of evaluation systems, and improvement of teachers' capabilities. However, research on CIP in industry-characteristic institutions remains relatively limited, particularly in the cross-domain area of "industry characteristics + big data technology + project-based teaching", where systematic experiences are still insufficient. Many existing efforts remain at the level of "listing ideological–political elements" or "simple embedding of cases", lacking holistic solutions that deeply integrate real engineering projects. Meanwhile, project-based teaching has been widely applied in big data–related courses but still encounters problems such as generic project sources, unclear difficulty gradation, and single evaluation mechanisms. How to organically embed ideological–political elements into project-based teaching, and enable students to internalize value recognition while solving complex engineering problems, is an issue that demands further exploration [4]. Preliminary teaching practice of this course, combined with a learning situation analysis of Big Data Technology students, reveals that: students generally exhibit "relatively strong data manipulation ability but weak modeling and analysis ability"; they lack sufficient understanding of shipping business; and they lack holistic thinking for big data architecture design and fault troubleshooting. Their literacy in professional ethics, engineering norms, and team collaboration also warrants improvement. A traditional classroom model dominated by technical lecturing tends to result in a "decoupling" between ideological–political education and professional teaching.

In this context, this study takes the project "Big Data–Assisted Risk Analysis for Waterway Construction" within the *Big Data Platform Deployment and Operation* course as a carrier, explores a project-based teaching reform pathway under the perspective of curriculum ideology and politics for big data platforms, and, through systematic implementation and effect evaluation, summarizes experiences that can be replicated.

2. Course and Learner Analysis

2.1. Course Positioning and Alignment with Competency Standards

Big Data Platform Deployment and Operation is offered in the third semester of the Big Data Technology program and is jointly developed by the university and industry partners. It is a core course aligned with the typical workflow of big data engineers. The course content is closely aligned with industry standards such as Information Technology—Requirements for Operation and Management Functions of Big Data Systems, as well as the specifications of HCIA for Big Data certification, while also covering key knowledge and skill points of vocational skills competitions such as "Big Data Application Development" [5].

The course is structured into three progressive modules, among which the third module focuses on shipping big data–based risk analysis and includes several projects. The project "Big Data–Assisted Risk Analysis for Waterway Construction" is a comprehensive practical project within this module. It encompasses core tasks such as business analysis, data collection, data storage, data processing, and visual presentation, and serves as an important segment for assessing students' comprehensive competencies and literacy.

2.2. Learner Foundation and Characteristics

The target learners are students in the Big Data Technology program at a higher vocational institution. They have completed courses such as Introduction to Shipping Big Data, Java Programming, Linux Operating System, and Database Application Development Technology. Most students already possess basic development and operation skills in Linux environments, thereby laying a technical foundation for in-depth study of big data platforms.

Process data collected via platforms such as SuperStarLearn and AI-based learning supervision systems, along with questionnaire responses and interview results, reveal the following characteristics of students' foundations:

Knowledge and skills: Students perform relatively well in scripting and basic data processing, but lack experience in big data architecture design, model construction, and integrated fault diagnosis.

Cognition and thinking: Engineering and systems thinking are comparatively weak; students tend to adopt piecemeal approaches instead of holistic solutions and pay insufficient attention to data quality and data security.

Values and attitudes: Some students have limited understanding of shipping business, and their professional identity and sense of mission require strengthening. Their awareness of data ethics and privacy protection also lacks systematic development.

Learning styles: Students show strong interest in intuitive resources such as animated microlectures and VR simulations and are willing to use AI tools to support learning. However, they are less receptive to abstract theoretical content and lengthy texts, and they prefer authentic, challenging project tasks.

3. Overall Design of Teaching Reform and Content Reconstruction

3.1. Building a Course Objective System of “Complying with Standards, Understanding Data, and Excelling in Analysis”

Based on the core competencies required for big data engineer positions, the course team proposes a talent training goal of “Standard Compliance, Data Comprehension, and Analytical Excellence.

Standard Compliance emphasizes adherence to industry standards and operating procedures, fostering safety awareness, quality awareness, and professional ethics.

Data Comprehension focuses on fundamental competencies in data collection, cleaning, storage, and governance.

Analytical Excellence refers to the integrated ability to conduct modeling and analysis, anomaly detection, and visual expression in complex business contexts

Accordingly, the course objectives are refined into three dimensions—knowledge, skills, and professional literacy—so as to align with national standards and certification specifications while incorporating industry requirements regarding professionalism and occupational ethics in the shipping field.

3.2. Reconstructing a Project-Based Content System around Typical Scenarios

In the overall course design, smart shipping serves as the main thread, and the content is integrated into three modules: “platform construction–data governance–shipping risk analysis”. Within each module, a progressive series of projects is designed.

Focusing on the “Big Data–Assisted Risk Analysis for Waterway Construction” project, the tasks are further decomposed to form a complete practice chain from business understanding to result reporting, including: analyzing business processes and data requirements for waterway construction risk; designing and deploying big data solutions for data collection and storage; building risk data pipelines and achieving multi-source data integration; constructing risk warning models based on vessel trajectories and construction information; and designing visual dashboards to present risk distribution and warning results. The project difficulty increases stepwise, covering key technical points while providing rich scenarios for the natural integration of ideological–political elements.

3.3. Overall Design of Curriculum Ideology and Politics

As shown in Figure 1, in line with the institution’s characteristics of “maritime heritage + smart shipping”, elements such as maritime spirit, the strategy of building a strong maritime nation, the mission of building a strong transportation country, and data ethics are integrated into the course, forming a “point–line–surface” structure of CIP.

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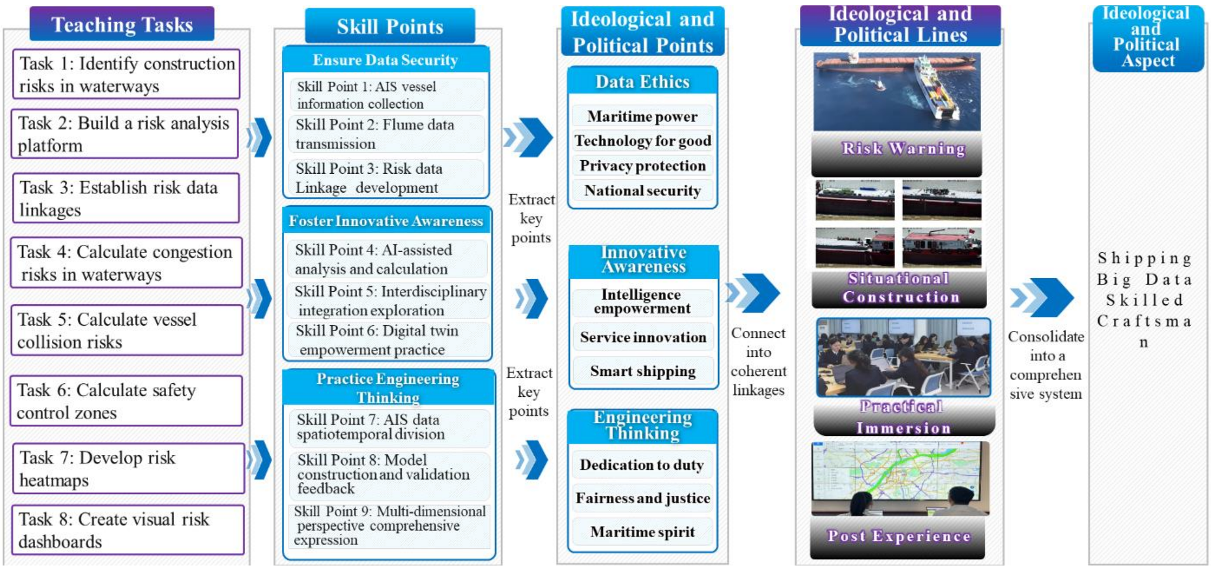

Figure 1: Curriculum Ideology and Politics

Points: Specific CIP elements are embedded in each task. For example, in the data security module, students are guided to reflect on "the consequences of vessel trajectory data leakage"; during model design, they discuss "algorithmic discrimination and fairness".

Line: With the goal of cultivating "big data skillful craftspeople with social responsibility and patriotic sentiments" as a main line, socialist core values and the national strategy of building a shipping power are woven throughout the teaching process.

Surface: Through comprehensive coordination of teaching objectives, content, activities, and assessment, a CIP content map that covers the entire course is constructed, shifting ideological–political education from fragmented infiltration to systematic provision.

4. Project-Based Teaching Model and Implementation Path

4.1. Teaching Environment and Resource Support

(1) Maritime Big Data Workshop

Relying on the Jiangsu Provincial Shipping Big Data Engineering Research Center, a "Maritime Big Data Workshop" is established. Real enterprise projects and industry data are introduced to build a "three-real" teaching environment—real projects, real data, and real positions—so that students can complete the entire process from data collection to visual presentation in a simulated computer lab.

(2) Digital Twin Waterway System

In cooperation with port and shipping enterprises, a digital twin waterway system is developed. It visualizes multi-source data such as vessel trajectories, hydrological conditions, and construction areas, supporting students' risk analysis and scenario simulation in virtual environments and offering a repeatedly operable "virtual reality" for classroom teaching.

(3) "Two-Platform, Three-Terminal" Blended Learning Environment

Using platforms such as SuperStarLearn an AI-based learning supervision system, a "two-platform, three-terminal" environment—mobile learning terminal, smart classroom terminal, and cloud-based training terminal—is constructed. It supports pre-class guided learning, in-class interaction, practice recording, and online testing, and enables data collection and analysis throughout the teaching and learning process.

(4) Granular and Digital Teaching Resources

Around typical knowledge points, the course team produces short videos, interactive animations, and operation script templates as granular learning resources. These are combined with VR-based digital waterways, virtual simulation and practice resources, and interviews with enterprise mentors, catering to students' preferences for "short-duration, high-frequency, and on-demand" learning experiences.

4.2. Project-Based Teaching Model

The course implementation follows a five-stage IDEAL [6] project-based teaching model—Identify, Define, Explore, Act, and Learn—forming a closed-loop process of "pre-class platform-based guided learning— in-class project-based progression—post-class workshop-based extended learning". Using the task "Building a Risk Data Pipeline" as an example.

(1) I: Identify the problem

The instructor presents cases of incidents that occurred during waterway construction through task cards and the digital twin system, and guides students to consider questions such as "Why is it necessary to grasp the dynamics of vessels in construction waters in real time?" and "What vulnerabilities exist in the current data pipeline?", thus stimulating problem awareness.

(2) D: Define the problem

Based on authentic business documents and construction specifications, students sort out data collection and synchronization requirements involving AIS data, construction plans, hydrological data, and other multi-source data, and clarify the technical goals and quality standards for "building a stable and reliable data pipeline". At the same time, they discuss the safety risks that may be caused by data distortion and delay, strengthening their awareness of standards and norms.

(3) E: Explore solutions

In groups, students use whiteboards, flowcharts, and AI tools to design multiple data collection and transmission schemes and compare the stability and scalability of different architectures. Instructors and enterprise mentors comment on these designs and guide students to comprehensively consider network environments, security strategies, and operation and maintenance costs.

(4) A: Act and implement

Each group implements its solution in a cloud-based training environment, completing operations such as deployment of collection scripts, configuration of message queues, and data ingestion into data lakes. The AI-based supervision system records the process, counts the number of errors and resource usage, and provides personalized hints.

(5) L: Learn and reflect

After completing the task, students submit logs and reflections via SuperStarLearn, summarizing the strengths and weaknesses of their solutions and team collaboration. Based on platform data, instructors conduct multi-dimensional evaluation and guide students to transfer accumulated experience to subsequent risk analysis tasks, forming a reflective cycle that integrates knowledge, skills, and literacy.

4.3. Using Granular and Digital Resources to Address Key Difficulties

Given that environment configuration for big data platform deployment is complex, fault points are scattered, and students are prone to "getting stuck", the course team decomposes abstract procedures into multiple "minimal learnable units" and provides supporting resources, including: Demonstration scripts and operation videos that help students quickly master key commands and parameters; VR digital waterway resources that link vessel monitoring and construction scenarios with back-end data in real time, enabling students to understand "where the data comes from" and "why data must be collected in this way"; A combination of virtual simulation and hands-on practice, in which online troubleshooting and offline lab operations validate and reinforce each other, enhancing students' knowledge transfer capabilities;

Microlectures delivered by enterprise mentors that transform real engineering cases into a "collection of common pitfalls", guiding students to deepen their understanding through review and reflection. These resources, integrated with the IDEAL model, effectively help students overcome major difficulties related to cluster construction, data pipeline building, and performance tuning.

4.4. Multi-Dimensional and Collaborative Implementation of Curriculum Ideology and Politics

Throughout the project process, the course team implements CIP goals via the following approaches:

(1) Embedding value guidance in problem scenarios

For example, when discussing the "consequences of failure in construction risk warning", students are guided to consider how data delay and equipment failure may threaten life and property, thereby reinforcing safety responsibility and bottom-line thinking.

(2) Highlighting national strategies in technical solution comparison

By comparing the development status of navigation and monitoring technologies at home and abroad, students develop an understanding of the importance of independent and controllable technologies and strengthen their sense of mission in serving the construction of a strong transportation country, a strong maritime country, and a digital China.

(3) Cultivating moral judgment through data ethics discussions

Debates and writing tasks are organized around social topics such as "big data–enabled price discrimination", "privacy leakage", and "algorithmic discrimination". Students are encouraged to examine the boundaries of data application from the perspective of engineers, thereby enhancing their data ethics literacy.

(4) Shaping professional spirit through team collaboration

Through job rotation and role-playing, students simulate roles including requirements analysts, platform engineers, and data analysts, experience different positions, and develop collaboration awareness, quality awareness, and craftsmanship spirit.

5. Learning Assessment and Effect Analysis

5.1. A Value-Added, Multi-Component Assessment System

The course establishes an integrated assessment system consisting of process-based, summative, and value-added evaluation:

Process-based evaluation: Relying on SuperStarLearn, the digital twin system, and the AI-based supervision platform, data are collected on students' pre-class preparation, classroom participation, training operation logs, script quality, and peer assessment results [7]. Instructors, enterprise engineers, students (self-evaluation), and AI systems jointly participate to form a multi-agent, multi-indicator comprehensive evaluation.

Summative evaluation: The final assessment is aligned with the standards of the HCIA for Big Data, examining not only knowledge mastery, but also students' integrated application ability in authentic scenarios. Value-added evaluation: Emphasis is placed on "growth relative to one's own starting point". By comparing pre-test and post-test scores, platform behavioral data, and project output quality, individual growth trajectories are depicted, guiding students to set goals of self-transcendence.

5.2. Significant Enhancement of Knowledge and Skills

According to platform statistics and certification outcomes, most students show significant improvement in their mastery of big data collection principles, analysis methods, storage

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strategies, and automated operation and maintenance, and the pass rate for the "Big Data Governance" certificate reaches a relatively high level. Some optimization proposals put forward by students in the course—such as "stage-wise validation" and "multi-level monitoring"—have been integrated by instructors into subsequent teaching designs. In project practice, students can skillfully configure data collection pipelines, master rules for identifying abnormal vessel behavior, and use methods such as density analysis to detect high-risk zones in construction waters. They are able to generate relatively complete risk analysis reports and visual dashboards, and their capabilities in target tracking, anomaly warning, and density analysis have been markedly enhanced.

5.3. Parallel Development of Core Literacy and Innovation Capability

With guidance from enterprise mentors, students develop a more intuitive understanding of engineering processes, quality standards, and collaboration mechanisms, thereby improving their engineering and systems thinking. Discussions and writing tasks on topics such as data ethics, intelligent recommendation, and waterway safety help students form clearer value judgments and a stronger sense of responsibility. Some students further extend the course project, apply for invention patents and software copyrights, and achieve good results in vocational skills competitions, industry contests, and innovation and entrepreneurship programs. This demonstrates their strong innovation awareness and practical capabilities.

6. Conclusion

From the perspective of curriculum ideology and politics, this study takes the project "Big Data–Assisted Risk Analysis for Waterway Construction" as the focal point and constructs a project-based teaching reform scheme for the course Big Data Platform Deployment and Operation. Practice demonstrates that:

First, using authentic industry projects as carriers and organically integrating professional knowledge, engineering practice, and ideological–political elements is conducive to strengthening students' professional identity and social responsibility, and to encouraging them to consciously align with national strategic needs when solving complex engineering problems.

Second, a data-driven teaching model built on digital twin and AI-based supervision platforms can accurately depict learning situations, optimize instructional decision-making, and significantly improve learning outcomes.

Third, the objective system of "Standard Compliance, Data Comprehension, and Analytical Excellence", combined with the comprehensive model of "IDEAL project-based teaching + point–line–surface curriculum ideology and politics + value-added assessment", provides a useful pathway for similar course reforms in industry-oriented higher vocational institutions.

Nonetheless, the reform still has room for improvement. Future efforts will focus on: (1) further introducing complex real-world enterprise cases, expanding the types and scales of multi-source heterogeneous data, and enhancing students' data sensitivity and ability to cope with complex scenarios; (2) deepening the integration of AI and teaching by exploring the in-depth application of intelligent recommendation, automated grading, and intelligent Q&A in the course; and (3) strengthening cross-course and cross-major collaborative design to build a program-wide framework for curriculum ideology and politics and project-based teaching, and ultimately forming a more systematic talent training scheme for smart shipping big data.

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