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Exploration and Practice of Big Data Technology Talent Cultivation Reform Based on the Integrated "Post–Curriculum–Competition–Certification–Research" Model

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Abstract: Against the backdrop of national strategies such as "Digital China" and "Transportation Powerhouse China," the big data industry has been developing rapidly, and there is a growing demand for interdisciplinary technical and skilled tale nts who are both proficient in data technologies and familiar with business processes in specific industries. As the main base for cultivating high-skilled talents, higher vocational institutions urgently need to carry out systematic reforms in talent cultivation objectives, curriculum systems, teaching models, and assessment mechanisms. The integrated "Post–Curriculum–Competition–Certification–Research" (PCCCR) model provides an important pathway to addressing problems such as misalignment between teaching content and job requirements, separation of classroom learning from project practice, and mismatch between course assessment and professional standards. Based on the big data technology program and using Huawei Certified ICT Associate (HCIT) for Big Data and other professional certifications as key levers, this paper, from the perspective of the PCCC model, systematically examines the practical challenges in big data talent cultivation; constructs a big data curriculum system that integrates "Post–Curriculum–Competition–Certification–Research" (PCCR); designs a project-based teaching model featuring "tiered progression and full-process integration"; explores mechanisms for deeply integrating certification content with course content and competition tasks; and analyzes the reform effects using teaching practice and performance data. The study shows that big data talent cultivation reform under the PCCC perspective helps achieve multi-dimensional alignment among job requirements, course content, competition projects, and certification standards, significantly enhances students' engineering practice capabilities, comprehensive data literacy, and career competitiveness, and provides a replicable and scalable practi cal paradigm for talent cultivation in big data technology programs at higher vocational institutions.

Keywords: Post–Curriculum–Competition–Certification-Research (PCCCR), Big data technology, Talent Cultivation, Project-based teaching, Huawei Certified ICT Associate (HCIT).

1. Introduction

Big data has become a key infrastructure driving the development of the digital economy. Whether in smart ports, intelligent shipping, financial risk control, or smart city governance, the collection, storage, analysis, and visualization of massive data all rely on big data technologies [1-2]. In the context of industrial upgrading and technological iteration, several problems have emerged in the training of big data technology talents at higher vocational institutions. Specifically, curriculum content lags behind industrial development and does not adequately cover emerging technologies such as cloud-native big data platforms, real-time computing, and intelligent analytics; classroom teaching is decoupled from enterprise projects, resulting in students who "know the theory but cannot apply it" and who "can operate tools but struggle to solve complex problems"; course assessment still relies mainly on written examinations and lacks effective alignment with enterprise competency models and professional qualification standards; and many teachers lack sufficient industry experience with new platforms and tools, which weakens their capacity to support high-quality project-based teaching.

The National Vocational Education Conference in 2021 proposed an integrated "Post–Curriculum–Competition–Certification" (PCCC) model, which organically connects work positions, curriculum systems, vocational skills competitions, and vocational qualification certificates to form a collaborative education mechanism [3-4]. This model provides overall guidance for deepening teaching reforms in big data technology programs. Meanwhile, industry leaders such as Huawei have developed certification systems such as HCIA for Big Data, which distill engineering norms, technical standards, and best practices into systematic knowledge frameworks and competency standards, thus offering a valuable "industry benchmark" for higher vocational institutions to promote learning and teaching through certification [5].

Against this background, the big data technology program, relying on platforms such as the Huawei ICT Academy and the Maritime Big Data Engineering Research Center, has launched a systematic exploration of big data talent cultivation reform under the PCCC perspective. The program reconstructs the curriculum system based on job requirements, innovates teaching models with project-based mainlines, integrates Huawei HCIA for Big Data certification content into courses and practical training, and incorporates big data skills competitions into classroom activities. The goal is to build an integrated talent cultivation framework that connects "Post–Curriculum–Competition–Certification–Research" (PCCR). Drawing on these practices, this paper systematically summarizes and reflects on the reform rationale, implementation pathways, and practical outcomes.

2. Practical Challenges in Big Data talent cultivation under the PCCC Perspective

The technology stack of the big data industry evolves at a high speed: it has shifted from an ecosystem centered on Hadoop batch processing, to a cloud-based architecture with unified computing engines represented by Spark and Flink, and further to intelligent analytics systems deeply integrating artificial intelligence algorithms with domain knowledge. Enterprise requirements for big data professionals have thus moved from "being able to write MapReduce programs" to "being capable of completing end-to-end data processing and analytics on cloud platforms."

However, in many higher vocational institutions, the big data curriculum system still focuses on traditional databases and static report analysis, and there is a significant gap between course structures and mainstream industrial platforms. Students' mastery of key competencies—such as data collection, distributed storage, real-time stream processing, and visualization—is neither systematic nor solid, making it difficult to meet the comprehensive ability requirements of positions such as big data platform operations engineers, data processing engineers, and big data development engineers.

Current classroom teaching primarily relies on theoretical lectures and basic lab exercises. Although some practical courses are scheduled, they are often limited to chapter-based mini-experiments and lack cross-course, cross-semester, and cross-role integrated projects. Students tend to complete tasks by "following instructions," yet seldom experience the full cycle of real projects—needs analysis, solution design, data collection and cleaning, indicator modeling, performance tuning, and result presentation. As a consequence, they exhibit insufficient "project thinking" and weak engineering competence. At the same time, higher vocational students are highly diverse in their backgrounds and foundations. A single teaching model and uniform project difficulty can hardly satisfy the learning needs of all students: some feel under-challenged, while others find tasks overwhelming, leading to suboptimal teaching outcomes.

In the context of rapidly developing professional certifications, big data technology programs commonly introduce various certification examinations. In practice, however, certificate training is often treated as an "extra task." The certification syllabi are not systematically aligned with course content, leading to disconnects between what is taught in class and what is required for certification exams. A few students obtain certificates through short-term intensive training, but their knowledge remains fragmented and poorly transferable to real projects. HCIA for Big Data, which comprehensively integrates data storage, data processing, data analysis, platform tuning, and secure operations, cannot fully play its role of "promoting learning, teaching, and application through certification" if it is not effectively integrated with the professional curriculum system and practical teaching.

Big data technology is not only an extension of computer science; it is also closely related to statistics, industry business processes, data governance, and legal and ethical issues. High-quality project-based teaching in big data requires teachers not only to master various platforms and tools but also to connect these technologies with concrete industry scenarios—such as smart shipping, smart ports, logistics scheduling, and risk warning—to design authentic, comprehensive, and challenging project tasks. Due to time constraints and limited access to production environments, frontline teachers often have few opportunities to participate in real enterprise projects and have limited hands-on experience with the latest big data platforms from companies like Huawei. As a result, classroom cases remain largely theoretical, and it is difficult to fully stimulate students' motivation to learn certification content and new technologies.

3. Talent Cultivation Based on the Integrated PCCR Model

3.1. Big Data Curriculum System Integrating Post–Curriculum–Competition–Certification–Research

Under the PCCC perspective, the core of big data talent cultivation reform lies in reconstructing the curriculum system. Based on in-depth research on regional industries and maritime big data application scenarios, the college relies on the Huawei ICT Academy platform to construct a big data curriculum system that integrates Post–Curriculum–Competition–Certification–Research (PCCCR).

"Position-based curriculum development" aims to establish a dynamic, industry-oriented curriculum updating mechanism. Starting from job competency elements, the program decomposes its talent cultivation objectives into four modules: general vocational literacy, fundamental big data capabilities, platform operations and development capabilities, and data analytics and industry application capabilities. The curriculum system is then rebuilt accordingly to realize the principles of "defining courses by positions and cultivating positions through courses." In practice, the college relies on jointly built practice bases with shipping enterprises and big data companies to establish a three-way mapping among course content, job skills, and industry standards. Industry experts are regularly invited to "diagnose" course standards and teaching content, and new platforms, tools, and norms are quickly incorporated through revisions of course standards, adjustment of chapters, and updates of cases. For example, when teaching distributed storage and computing, components of the Huawei big data platform currently used by enterprises and relevant business log data are introduced. When teaching data governance, enterprise data quality management standards and metadata management tools are included so that courses are no longer limited to "textbook Hadoop" but target "real-world big data platforms."

"Research-integrated curriculum development" means using research and projects to upgrade course content. It emphasizes transforming the new methods, tools, and datasets generated in teachers' big data application research and horizontal projects into teaching resources. Relying on the Maritime Big Data Engineering Research Center, teacher teams have accumulated a wealth of real data and cases in areas such as intelligent ship management, route optimization, and port operation efficiency analysis. In the curriculum, projects such as the "Ship Data Analysis System" are abstracted as teaching mainlines: introductory courses use simplified datasets and tasks, while advanced courses introduce more complex indicators and models to form a cluster of practice tasks under the same project theme but at different difficulty levels. Students conduct analyses around the same industry scenario over multiple semesters, thereby deepening their understanding of the industry and strengthening engineering practice capabilities.

"Competition-driven curriculum improvement" uses competition standards to push teaching quality upward. Big data skills competitions impose high requirements on data processing, algorithm implementation, and engineering collaboration. The college decomposes national and provincial big data skills competition events into a series of knowledge points and competency points, and redesigns typical competition tasks as course cases, phase projects, or comprehensive practice tasks. In the basic course stage, students are guided to become familiar with data collection, cleaning, and statistical analysis and to complete small-scale, competition-inspired tasks. In the core course stage, small-group collaboration on "simplified competition projects" is arranged, training students across the full process from task decomposition and division of labor to result presentation. In the extended practice stage, students are encouraged to participate in real competitions, with competition results included as an important component of course assessments. Through "promoting learning and teaching through competitions," students' practical skills are strengthened and teachers are prompted to continuously adjust teaching content and methods to meet the standards required on the competition stage.

"Certification-based curriculum validation" means embedding Huawei big data certifications into the course assessment system. In reconstructing the big data curriculum system, HCIA for Big Data certification is no longer treated as an additional burden but as an important "assessment tool" to evaluate learning outcomes. On one hand, course content is carefully mapped to certification syllabi: HCIA-level fundamental theories and platform concepts are aligned with courses such as "Introduction to Big Data" and "Deployment and Operations of Big Data Platforms," while HCIP-level topics—cluster tuning, fault diagnosis, performance optimization, advanced development, and secure operations—are integrated into core courses such as "Distributed Computing Frameworks" and "Big Data Development and Practice." On the other hand, certification elements are included in course assessment. Students who obtain HCIA are granted certain credits or score conversions in corresponding courses; completion of HCIP-related labs or comprehensive tasks is used as an important criterion for the "excellent" grade in project assessments; and teachers are encouraged to develop supporting teaching resources around certification experiments so that the same set of labs can be used both for classroom teaching and certification training. Through certification-based validation, course objectives and certification standards are organically unified, enabling students to progressively meet the competency requirements for certified professionals while completing the curriculum.

3.2. Design of a Project-Based Teaching Model Featuring Tiered Progression and Full-Process Integration

Building on the reconstructed curriculum system, the big data technology program has developed a project-based teaching model centered on typical industry projects such as the "Ship Data Analysis System." This model features tiered progression across "basic–intermediate–advanced" levels and full-process integration across "classroom–lab–project–competition–certification."

First, a "backbone project" is identified to move from fragmented skill training to systematic engineering practice. The selection of backbone projects follows three principles. (1) Industry relevance: projects should be rooted in real business scenarios such as smart shipping and smart ports, thereby highlighting the maritime characteristics of the program. (2) Decomposability: a backbone project should be divisible into multiple subtasks that can be completed in different courses—such as data collection, cleaning, modeling, visualization, and operations. (3) Iterability: projects should be continuously expandable and upgradable according to industry needs and platform evolution, forming a dynamically updated project family. Taking the "Ship Data Analysis System" as an example, lower-grade students focus on "static data statistics and visualization," intermediate students focus on "batch analysis and feature extraction," and upper-grade students focus on "real-time stream processing, early-warning models, and cockpit-style visualization." This ensures both progressive skills development and consistent project contexts.

Second, tiered task design accommodates students with different foundations. To address the large variance in students' prior knowledge and abilities, project-based teaching adopts three levels of difficulty—basic, intermediate, and advanced. The basic level targets students with weaker foundations and emphasizes tool usage and operational norms, such as configuring ETL workflows in visual interfaces and using visualization components to produce simple reports. The intermediate level targets the majority of students and emphasizes programming and problem-solving abilities, such as using Python or Spark for data cleaning and analysis and writing scripts to implement batch task scheduling. The advanced level targets core students and competition team members and emphasizes innovation and holistic solutions, such as performing cluster tuning, real-time monitoring, multi-source data fusion analysis on the Huawei big data platform, and designing complete enterprise-oriented solutions. Through tiered assignments, guidance, and assessment, all students are ensured to reach the "pass threshold," while high-achieving students are provided with space for in-depth development.

Third, the teaching process achieves integrated "learning–practice–competition–assessment–extension." Project-based teaching is organized along a five-step logic. (1) Learning: contextual introduction and focused explanation of key concepts and principles are provided by drawing on authentic business scenarios—for example, using a case of low port berth scheduling efficiency to guide students to consider which data should be collected and how these data should be stored and analyzed. (2) Practice: task-driven mini-projects are implemented by student teams according to course content, such as constructing a data warehouse for vessel berthing records or performing ship trajectory data cleaning and matching. (3) Competition: small-scale in-class competitions, such as data cleaning contests or dashboard design contests, are designed to encourage students to compete in quality, efficiency, and creativity; outstanding teams are then selected into school-level competitions to prepare for provincial and national events. (4) Assessment: a comprehensive evaluation system that combines teacher assessment, enterprise mentor assessment, peer assessment, and process portfolios is adopted. Students' performance in collaboration, innovation, and problem solving during project implementation is included in course assessment, and completion of HCIA/HCIP-related experiments and certifications is used as an important basis for evaluation. (5) Extension: excellent projects are archived into a case library, transformed into demonstration videos or prototype systems, and showcased in open days and enterprise exchange activities. Students are encouraged to transfer their learning to other scenarios, extending from "ship data analysis" to "port operation efficiency analysis," "logistics route optimization," and beyond to broaden their application horizons.

3.3. Practical Pathways for Integrating Curriculum and Certification

In the reform practice, HCIA for Big Data certification is not treated as an additional end-of-program examination but rather as a key pillar running through the entire process from objective setting and implementation to outcome evaluation.

First, certification standards are used to refine course learning objectives. Huawei's certification system specifies knowledge and competency requirements at different levels, providing authoritative references for concretizing course objectives. When revising the talent cultivation scheme, the big data program aligns the HCIA for Big Data syllabus with course standards item by item and designs differentiated course learning objectives. In basic courses, students are expected to achieve HCIA-level knowledge and operational requirements, such as mastering fundamental concepts of big data platforms, key components, and basic operations. In core and practice-oriented courses, HCIP-level competencies are embedded, including large-scale cluster planning, resource tuning, performance diagnosis, and advanced development.

Second, certification labs are used to reconstruct practical teaching content. Certification labs often derive from real enterprise scenarios and have high engineering value. The program organizes teachers to pedagogically redesign HCIA/HCIP lab projects. Lab steps are decomposed into four stages: theoretical explanation, demonstration, student simulation, and extended exploration. Relevant data and cases from maritime scenarios are added so that students deepen their understanding of industry applications while meeting certification requirements. Some certification labs are incorporated into course assessment tasks, and students are encouraged to conduct extended experiments such as parameter tuning, fault injection, and performance comparison. This enables students to gradually adapt to the procedures and thinking patterns required for certification exams in the classroom, while significantly enhancing the "engineering flavor" of course practice.

Third, a multi-dimensional incentive mechanism combining "certificates + projects" is established. To prevent students from perceiving certifications as irrelevant extra tasks, the program designs incentives from multiple dimensions including credit recognition, awards and honors, and employment recommendation. HCIA/HCIP certifications are linked to course grades, and students who obtain certifications receive bonus points or credit substitutions in the corresponding courses. When selecting outstanding graduates and skill pacesetters, holding high-level certifications and participating in high-level projects are regarded as important criteria. In campus recruitment and internship recommendation activities carried out jointly with enterprises, students with Huawei big data certifications are given priority for relevant positions. Through the dual incentives of project achievements and certification levels, students are motivated to integrate certification learning into their daily study and practice, transitioning from "being asked to take exams" to "wanting to earn and use certificates."

3.4. Workshop Practice Project Based on Ship Data Analysis

In the "Ship Data Analysis System" backbone project, students rely on the maritime big data platform jointly built by the college and industry authorities to complete a full-process practice from data collection and cleaning to modeling and visualization. Specifically, lower-grade students are responsible for collecting and organizing basic ship information and historical route data and for producing basic statistical reports using visualization tools. Intermediate students use computing frameworks such as Spark to clean trajectory data, extract features, and analyze route congestion and berth time distributions. Upper-grade students build real-time data processing pipelines on the Huawei big data platform to handle ship position and meteorological data streams, design early-warning rules, and develop dynamic monitoring dashboards.

Throughout this process, multiple courses coordinate and connect; students from different grades work in vertical teams; and teachers and enterprise engineers provide joint supervision and guidance. The final project outputs are used not only for course assessments but also showcased at school–enterprise cooperation seminars and industry exhibitions, thereby realizing the unified goals of teaching, research, and industry service.

4. Conclusion and Prospects

The big data talent cultivation reform under the PCCC perspective represents a systematic endeavor by higher vocational institutions to proactively address the challenges of the digital economy and industrial upgrading. Based on practices in a big data technology program, this paper has systematically analyzed the PCCR-integrated talent cultivation model from the dimensions of curriculum system reconstruction, project-based teaching model design, and pathways for embedding Huawei's HCIA for Big Data certification. The practice demonstrates that, first, taking job requirements as the driving force and courses as the carrier, and organically integrating competitions and certifications into practical teaching, can significantly enhance students' engineering practice capabilities and professional literacy in big data. Second, deeply aligning enterprise certification systems with curriculum standards helps achieve multi-dimensional consistency among industry standards, curriculum standards, and student competency standards. Third, building project-based teaching models characterized by tiered progression and full-process integration around typical industry projects can effectively alleviate the issue of heterogeneous student foundations and promote personalized development on the basis of guaranteeing minimum competency attainment.

Nonetheless, this study has some limitations that merit further improvement. For instance, how to balance certification training with students' overall learning load when scaling up reforms, how to strike a balance between breadth and depth of application within limited credit hours, and how to extend the influence of big data technologies through cross-disciplinary collaboration remain issues that require continuous tracking and optimization in future practice and research. Looking ahead, the big data technology program will continue to take PCCR integration as the main thread, further promote cross-fertilization between big data and emerging technologies such as artificial intelligence, the Internet of Things, and blockchain, deepen collaborative education mechanisms with leading enterprises, and explore precise teaching pathways based on learning analytics and student profiling. The goal is to cultivate more high-level big data technical and skilled talents who possess patriotism, craftsmanship, data thinking, and industry vision, thereby contributing to the development of the digital economy and smart shipping.

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References

[1] Ochuba, Nneka Adaobi, et al. "Strategies for leveraging big data and analytics for business development: a comprehensive review across sectors." Computer Science & IT Research Journal 5.3 (2024): 562-575.

[2] Ajala, Olakunle Abayomi, et al. "Reviewing advancements in privacy-enhancing technologies for big data analytics in an era of increased surveillance." World Journal of Advanced Engineering Technology and Sciences 11.1 (2024): 294-300.

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

[4] Wei, Xue. "Research on The Curriculum Reform of Architectural Decoration Engineering Technology Under the Background Of ‘Post-Course-Race-Certificate’ Integration." International Journal of Social Sciences in Universities 7(3): 128-131.

[5] Chen, Chunyang, Shuanglong Pang, and Desheng Zeng. "Research on the Collaborative Education Model between School and Enterprise for Computer Majors Based on Huawei Certification Standards." SHS Web of Conferences. Vol. 171. EDP Sciences, 2023: 1-5.