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Exploring Talent Development Reform of IoT Application Technology in Higher Vocational College via Post-Course-Competition-Certificate Integration

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Abstract: This study establishes a standardized curriculum framework that systematically integrates vocational posts, academic courses, skill competitions, and vocational certificates into a cohesive educational model for higher vocational institutions. It further constructs a dual-driven talent development mechanism grounded in university-enterprise collaboration, complemented by a comprehensive faculty development initiative designed to cultivate instructors who possess both theoretical expertise and practical industry qualifications. A multi-dimensional assessment system is also developed to evaluate student competencies across academic, practical, and professional dimensions. Taking the Internet of Things Application Technology program at City College of Huizhou as a representative case study, this paper elaborates on the specific implementation pathways and operational strategies of the aforementioned integrated education model. The practical outcomes demonstrate that this pedagogical approach effectively enhances students' performance in national and provincial skill competitions, as evidenced by significantly improved award-winning rates, while simultaneously increasing the proportion of students obtaining relevant vocational certifications. The empirical findings of this research offer actionable and transferable references for institutions seeking to optimize talent cultivation strategies in Internet of Things and related applied technology disciplines within the higher vocational education sector.

Keywords: Post-Course-Competition-Certificate Integration; Higher Vocational Education; Internet of Things Application Technology; Talent Development; Curriculum System

1. Introduction

Vocational education serves as the main platform for training skilled technical personnel, and its reform and development are closely linked to evolving industrial demands. Released in 2019, the National Plan for the Reform of Vocational Education sets clear requirements to deepen industry-education integration and college-enterprise cooperation, and optimize the education mechanism that combines moral cultivation, vocational skill training and work-study arrangements [1,2]. Issued jointly by the General Office of the CPC Central Committee and the General Office of the State Council, the Opinions on Promoting the High-Quality Development of Modern Vocational Education proposes to improve the comprehensive education mechanism based on Post-Course-Competition-Certificate Integration. Curriculum design and compilation need to follow real production procedures and on-the-job demands. In the meantime, colleges ought to build standardized practical training frameworks with modular layouts, so as to enhance students' practical operational skills [3].

The Internet of Things, an emerging advanced technology that realizes interconnection among smart devices, has gained extensive adoption in multiple industrial fields. This trend has led to a notable gap in professional talent supply within the industry. Two typical dilemmas persist at present: businesses find it tough to hire

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candidates who possess qualified professional skills, whereas graduates from vocational institutions face barriers when seeking ideal career positions. The IoT Application Technology program offered by City College of Huizhou also suffers from such drawbacks, which can be summarized into three major dimensions. To begin with, the present curriculum fails to match the practical demands of real jobs. Major courses such as Sensor Application Technology and Wireless Communication Technology place too much emphasis on theoretical lecturing, with little combination with real workplace scenarios. For this reason, new graduates are unable to get accustomed to work posts in a short time after graduation. Secondly, most in-college training activities are confined to basic verification experiments, due to the lack of practical working experience among teaching staff. Furthermore, the collaboration between colleges and enterprises stays at a shallow level. Industrial companies seldom take part in the whole process of talent cultivation, so students cannot receive sufficient training to polish their operational proficiency and comprehensive application skills. Thirdly, the existing evaluation mechanism is rather simplistic. There is no effective connection between regular classroom courses, vocational skill contests and professional certificate evaluations. Skill competitions run separately from daily teaching arrangements, and the assessment criteria for vocational certificates are not integrated into routine coursework. All the above problems largely lower students' enthusiasm for taking part in skill contests and certificate assessments. In order to train high-quality skilled workers that satisfy corporate recruitment demands, it is imperative to promote talent cultivation reform based on the concept of Post-Course-Competition-Certificate Integration.

2. Connotation of Post-Course-Competition-Certificate Integration

As an innovative talent development model in vocational education, , Post-Course-Competition-Certificate Integration unifies four key components for vocational education, including professional posts, curricula, skill contests and vocational qualification certificates [4,5]. This integration ensures that learning outcomes align closely with industry standards, enhances students' practical competencies through authentic assessment mechanisms, strengthens the relevance of curricular design to real-world occupational demands, and promotes seamless transitions from academic training to workplace readiness and formal credentialing.

2.1. Professional Job Competency Standards

This section establishes comprehensive professional competency standards aligned with authentic occupational roles across key industry sectors. Vocational training programs must dynamically adapt to evolving industrial requirements and enterprise operational needs, ensuring curricular relevance and workforce readiness. Vocational posts constitute the foundational anchor of vocational talent cultivation, establishing core standards for personnel development [6-8]. All vocational training initiatives need to keep pace with industrial and corporate development demands. In this way, the theoretical knowledge and hands-on skills mastered by students can fully satisfy the assessment rules applied in actual workplace scenarios.

2.2. Curriculum System

The curriculum system constitutes the comprehensive structural framework of a vocational education program, encompassing course sequencing, credit allocation, learning outcomes mapping, and integrated assessment strategies. Each course module undergoes systematic design and periodic revision grounded in rigorous analysis of authentic occupational requirements, industry competency standards, and evolving technological practices, thereby ensuring pedagogical relevance, skill alignment with workplace expectations, and sustained responsiveness to labor market dynamics [9].

2.3. Vocational Skill Competitions

Skill competitions orient daily teaching, while vocational qualification certificates validate learning outcomes [7,10]. Well-planned vocational skill competitions serve as a

vital pedagogical strategy to systematically enhance students' hands-on operational proficiency, problem-solving agility, and innovative thinking. Competition denotes skills competitions that stimulate students' practical abilities and innovative spirit, while competition content reflects the latest industry technologies and standards.

2.4. Vocational Qualification Certificates

Vocational qualification certificates serve as officially recognized credentials that objectively validate an individual's mastery of domain-specific knowledge, technical competencies, and hands-on operational proficiency. These certifications are systematically aligned with nationally endorsed occupational standards and industry-validated competency frameworks, they are also regarded as a necessary qualification for newcomers to embark on relevant career paths.

By centering assessment and instruction on demonstrable workplace capabilities—supported through curriculum modernization, participation in standardized skill competitions, and seamless integration with nationally accredited vocational certification pathways—this cohesive pedagogical approach effectively aligns educational outcomes with evolving industrial requirements [6]. It offers a comprehensive, practice-oriented framework for enhancing the quality and relevance of Internet of Things (IoT)–focused programs in higher vocational institutions, ensuring graduates possess both theoretical grounding and applied readiness for real-world technological deployment.

3. Reform Measures for Talent Development of IoT Application Technology Programs in Higher Vocational College

3.1. Formulate Talent Development Schemes Integrated with Post-Course-Competition-Certificate Ideas

3.1.1. Conduct Field Investigations and Clarify Training Objectives

The reform began with a stakeholder survey. Over several months, the research team visited IoT companies in Huizhou and the surrounding area—TCL, Desay SV, Shenzhen Yutai, among others—as well as peer vocational colleges and recent graduates. The aim was to map four things: where the local IoT industry was headed, what kinds of jobs were being created, which certificates employers actually cared about, and how the skills competition landscape was evolving.

What emerged was a fairly clear picture. The Huizhou-area IoT sector clusters around smart home products, industrial IoT, and smart agriculture. Four job categories dominate: system integration engineers (roughly 45% of openings), operations and maintenance engineers (about 25%), application developers (18%), and embedded engineers (12%). The core technical skills these jobs want—sensor and RFID work, communication network commissioning, system integration and maintenance—lined up well with the National Vocational College Skills Competition modules, particularly the IoT Application Development event. The two certificates that kept coming up in employer conversations were IoT Installation and Commissioning Technician and Information and Communication Technology Administrator.

The survey further clarified core requirements for the program, including training objectives, training specifications, curriculum design, and practical teaching. Based on the survey findings and relevant standards, the program's training objective was defined as: cultivating high-skilled talent with firm ideals and beliefs, well-rounded development in moral, intellectual, physical, aesthetic, and labor education, oriented toward the IoT industry in the Guangdong-Hong Kong-Macao Greater Bay Area, equipped with professional knowledge in IoT perception technology, network communication technology, and application development technology, and possessing core competencies in IoT system integration, equipment maintenance, and application development, capable of engaging in IoT-related positions.

3.1.2. Reconstruct Course System Based on Post-Course-Competition-Certificate Integration

The old curriculum followed a standard three-stage model: basic courses, specialized courses, then a block of concentrated practical training, where the rapid evolution of IoT technologies frequently outpaces curriculum updates [11,12]. Aligned with the latest national guidelines for vocational education curriculum development, a restructured course system has been designed around four integrated and mutually reinforcing clusters. This reconstruction systematically incorporates core professional competencies, essential disciplinary knowledge, applied skills emphasized in national and provincial vocational skill competitions, and the standardized assessment criteria embedded in industry-recognized occupational qualification certificates. Such curriculum can adapt to the changing demands of the entire IoT industrial chain, and realize deep integration between talent cultivation and industrial job demands.

3.1.2.1 Vocational Basic Course Cluster

This cluster comprises core foundational courses such as C Programming Language, Electrical and Electronic Circuits, and Fundamentals of Computer Networks, all carefully selected to cultivate essential technical competencies [13]. These courses collectively establish a robust professional knowledge base, enabling students to grasp fundamental principles of hardware-software interaction, circuit analysis, and network architecture. They directly support the development of practical skills required for entry-level positions in the Internet of Things domain, ensuring graduates meet industry-standard literacy benchmarks in embedded systems, signal processing, and data communication protocols.

3.1.2.2 Core Competency Course Cluster

This cluster systematically integrates multiple foundational and applied competencies into the curriculum framework, with emphasis on IoT application development, system integration, operation and maintenance, as well as foundational innovation and entrepreneurship capabilities. Aligned with industry demand for talent in core occupational roles—including IoT system integration engineers and IoT application developers—the program delivers targeted instruction through specialized courses such as Single-Chip Microcomputer Application Technology and IoT Communication Technology. Pedagogical design incorporates authentic work tasks derived from real-world engineering scenarios, technical requirements drawn from national vocational skill competitions, and essential knowledge domains specified in standardized professional certification assessments. For example, the course IoT Communication Technology centers on wireless sensor network deployment as its primary capstone project, integrating network configuration procedures adapted from competition guidelines with practical implementation of communication protocols mandated by current certificate evaluation criteria.

3.1.2.3 Competition and Certificate Integrated Course Cluster

Through an in-depth analysis of the "IoT Application Development" event in the National Vocational College Skills Competition, core skill elements were extracted, including "wireless sensor network construction based on ZigBee/LoRa," "IoT cloud platform data access and visualization," and "smart device control program development." These elements were transformed into practical projects within courses such as "IoT Application Comprehensive Practical Training" and "IoT Application System Development." Research on international skills competitions has demonstrated that integrating competition-based training with formal vocational curricula significantly strengthens both technical competence and essential soft skills such as problem-solving, creativity, and self-regulation [14]. Meanwhile, referencing the assessment syllabus for the "IoT Installation and Commissioning Technician" certificate, assessment points such as "sensor installation and commissioning," "IoT gateway configuration," and "system fault diagnosis" were incorporated into courses including "Information and Communication Technology" and "IoT Application Development." Students can complete the

corresponding certification through course study, and a mutual recognition and exchange system between course credits and certification certificates has been established.

3.1.2.4 Innovation and Expansion Course Cluster

The Innovation and Expansion Course Cluster rounds out its offerings with courses including Python, AI Technology, and Routing and Switching. This integration enhances students' technical competencies, fosters analytical and creative problem-solving skills, and deepens their understanding of emerging digital infrastructure. It also exposes students to where the industry is heading, rather than just where it stands today.

3.2. Optimize the Talent Development Mode: University-Enterprise Collaboration and Dual-Driving Mechanism

This approach systematically integrates university-enterprise collaboration throughout the curriculum, establishing a dual-driving mechanism that synergistically advances both academic rigor and industry relevance. Student development emphasizes not only foundational professional literacy—such as domain-specific knowledge, ethical reasoning, and communication competence—but also higher-order innovative capabilities, including critical thinking, problem-solving in authentic contexts, interdisciplinary integration, and adaptive learning. These competencies are cultivated progressively across all stages of the educational journey, from foundational coursework to capstone projects and internships, ensuring alignment with evolving societal and industrial demands.

3.2.1. School-Enterprise Collaboration

Schools and enterprises collaboratively develop talent cultivation plans, and timely integrate the new knowledge, technologies and industry standards required by professional positions into the curriculum system. Optimizing curriculum design remains a core task in advancing Post-Course-Competition-Certificate integrated education[15]. Via joint curriculum development, on-campus teaching delivered by enterprise practitioners, and supervision of off-campus on-the-job internships, the two parties jointly implement the talent cultivation process and evaluate the overall cultivation quality. Furthermore, schools and enterprises co-establish collaborative education programs in various forms, including modern apprenticeship programs and order-directed cultivation programs, with a focus on aligning teaching content with job requirements. A work-integrated learning pedagogy is implemented, and differentiated hierarchical precision cultivation is carried out to promote dual-subject education. In the process of teaching implementation, classroom teaching and practical training, theoretical instruction and hands-on practice, as well as in-school teachers and enterprise engineers are organically integrated, so as to realize the seamless connection between theoretical teaching and practical operation, and achieve the goal of "integration of positions and courses". Specifically, real enterprise projects are taken as the core carrier of teaching, and course content is decomposed into specific project tasks. In the *IoT Application System Development* course, the "Smart Agriculture" project from a cooperating enterprise is adopted as a teaching case; students complete the full development workflow in groups, covering requirement analysis, solution design, equipment selection, and system commissioning. In the *Comprehensive Practical Training of IoT Application* course, enterprise engineers are invited to participate in teaching activities. At the practical training base, real operation and maintenance scenarios are simulated, and students complete the design and implementation of projects such as "Smart Classroom" and "Smart Home" under the guidance of engineers, which comprehensively improves their professional application capabilities. By participating in the above-mentioned project-based tasks, students can systematically master relevant professional knowledge and practical skills.

3.2.2. Dual-Driving Mechanism

Two core supporting elements—vocational skill contests and formal qualification certificates—serve as foundational pillars for the institution's talent development system.

A structured, multi-tiered training framework has been systematically established, encompassing contest platforms at institutional, provincial, and national levels. Campus-level competitions are conducted on a regular basis to identify high-potential students, who then undergo targeted coaching and advanced preparation before advancing to higher-level provincial and national events. This tiered approach ensures progressive skill escalation, fosters healthy academic competition, and cultivates a culture of excellence grounded in practical competence. Moreover, the integration of contest participation into pedagogical planning reinforces alignment between curricular objectives and real-world occupational standards.

Student performance in vocational skill contests and attainment of industry-recognized qualification certificates are formally embedded within the institution's routine teaching evaluation system. To enhance granularity and fairness in assessment, skill credits have been introduced as a distinct, quantifiable metric reflecting applied proficiency. These skill credits are fully convertible into standard academic course credits, thereby enabling flexible academic pathways and recognizing experiential learning equivalently with classroom instruction. Furthermore, skill credit accumulation serves as a key criterion in comprehensive student evaluations, including scholarship allocation, honors designation, and selection for advanced training programs. This integrated incentive mechanism not only strengthens student engagement in extracurricular skill development but also promotes sustained enhancement of professional competencies aligned with evolving industry demands and national vocational education reform priorities.

3.3. Implement the Three Improvements and Two Introductions Strategy to Build Dual-Qualified Teaching Teams

The successful implementation of the Post-Course-Competition-Certificate integrated education model fundamentally depends on a teaching team possessing both robust pedagogical competence and substantial practical experience in industry or professional practice. To systematically enhance the professional capacity and dual-qualification profile of its faculty, the college has adopted a targeted human resource development strategy comprising three internal enhancement initiatives for full-time instructors—namely, improvement in teaching methodology, improvement in applied research capability, and improvement in technical practice proficiency—alongside two external recruitment pathways: the introduction of senior industry practitioners as part-time lecturers and the introduction of distinguished experts from research institutions or enterprises to serve as curriculum consultants or project mentors.

3.3.1. Three Improvements for Full-Time Teachers

Addressing persistent challenges observed among full-time faculty—particularly the misalignment between classroom instruction and real-world industry demands, limited capacity to effectively mentor students in vocational skill competitions, and delayed or inconsistent acquisition of nationally recognized vocational qualifications—the institution has implemented three targeted improvement measures.

First, systematic enhancement of teachers' hands-on technical proficiency is prioritized through a mandatory, structured enterprise immersion program. Each academic year, all full-time instructors are required to complete a minimum of thirty consecutive days of on-site engagement at partner enterprises specializing in Internet of Things (IoT) technologies. During these placements, faculty members actively contribute to authentic industrial workflows—including but not limited to sensor network architecture design, edge-to-cloud data integration, IoT application platform customization, and gateway firmware optimization. This sustained exposure ensures continuous updating of knowledge regarding evolving communication protocols (e.g., LoRaWAN, NB-IoT, Matter), safety-compliant deployment practices, and evolving employer expectations for technical roles [16]. Furthermore, documented industrial tasks, troubleshooting logs, and anonymized project deliverables are systematically curated and adapted into case-based learning modules, laboratory exercises, and capstone project

frameworks—thereby reinforcing curriculum-industry coherence and enabling students to develop applied problem-solving competencies grounded in current practice.

Second, improve targeted competitive coaching. Teachers were required to serve as coaches or judges for IoT Application Development and Embedded System Application Development events. Regular competition-themed seminars became part of the calendar. Through this work, teachers internalize the competition rules—how equipment gets commissioned, how data is acquired, what the scoring criteria actually reward. They learn to help students crack the hard parts: sensor node deployment, wireless protocol configuration. And along the way, they figure out how competition skills map back onto courses like Sensor Application Technology and Microcontroller Application and Development. The international evidence on this is worth noting. Research on skills competition participants has shown that deliberate practice combined with formal vocational education and expert mentoring improves long-term career outcomes and deepens vocational expertise [14].

Third, institutional incentives and structured support mechanisms are provided to facilitate timely attainment of nationally accredited vocational credentials. Emphasis is placed on high-demand, competency-based certifications such as the IoT Installation and Commissioning Specialist (Level 2 and above) and the Information and Communication System Administrator (Level 2 and above), both of which reflect rigorous, standards-aligned assessment of practical expertise. To ensure fidelity between certification requirements and instructional delivery, faculty undergo dedicated training on the national occupational skill standards framework, including task analysis, performance evidence collection, and assessment methodology. As a result, key competencies embedded in certification blueprints—including network configuration, device interoperability testing, and system commissioning documentation—are deliberately scaffolded across semester-long courses, laboratory sequences, and integrated project assessments—thus embedding qualification readiness within the regular academic workflow without compromising academic rigor or curricular integrity.

3.3.2. Strengthen the Integration of Teaching Staff with Industry Enterprises to Foster the Development of a Dual-Qualified Faculty Team

To address the common challenge of limited frontline industrial exposure and constrained professional perspective among on-campus teaching staff, the college actively incorporates external technical expertise and industry-based intellectual resources into its pedagogical ecosystem. This strategic initiative aims to bridge experiential gaps through structured collaboration rather than isolated knowledge transfer, thereby enhancing the authenticity and applicability of curriculum delivery.

On one hand, the college employs senior technical specialists from leading enterprises as part-time instructors. These specialists possess more than three years of frontline project experience in IoT system integration and intelligent hardware research and development. They deliver lectures for core practical courses and conduct paired teaching and research activities with full-time teachers. Both sides jointly design real IoT projects based on Huawei Cloud and Alibaba Cloud, and guide students to complete full-cycle project practice. This measure narrows the gap between teaching contents and actual job requirements.

On the other hand, the college establishes a professional construction advisory committee comprising distinguished industrial leaders, senior enterprise technical directors, and recognized academic experts. Committee members contribute through regular expert lectures on emerging technologies such as edge AI, low-power wide-area networking, and secure firmware development, as well as facilitated technical salons that foster interdisciplinary dialogue. They also conduct rigorous, evidence-informed reviews of talent development frameworks and participate in the continuous refinement of learning outcomes, assessment criteria, and competency benchmarks for key IoT-related courses. Their sustained involvement ensures curricular responsiveness to rapid technological shifts and market dynamics, while simultaneously supporting on-campus

faculty in expanding their domain knowledge, refining pedagogical strategies, and strengthening applied research capabilities.

3.4. Establish a Multi-Subject and Multi-Indicator Comprehensive Assessment System

To achieve the development goals of Post-Course-Competition-Certificate integration, the college implements a multi-subject and multi-indicator comprehensive assessment system that systematically integrates academic performance, hands-on technical proficiency, innovation capacity, teamwork competence, and ethical awareness. This approach transcends conventional single-dimension evaluation methods by incorporating formative and summative assessments across diverse learning contexts—including classroom instruction, laboratory practice, project-based learning, and extracurricular competitions—thereby enabling a holistic, evidence-based judgment of students' professional knowledge, practical skills, and comprehensive literacy.

3.4.1. Diversified Assessment Subjects

The assessment panel is composed of on-campus instructors, enterprise mentors, and industrial experts, each fulfilling distinct and complementary roles in the evaluation process. On-campus instructors focus on students' grasp of foundational theoretical concepts and core professional competencies through structured coursework and examinations. Enterprise mentors observe and evaluate students' hands-on operational capabilities, adaptability, and capacity to address authentic workplace challenges during internships or project-based learning. Industrial experts contribute by assessing the alignment of students' vocational certification attainment and holistic professional development—including communication, teamwork, ethical judgment, and industry-relevant soft skills—with current and emerging sectoral demands and standards.

3.4.2. Multi-Dimensional Assessment Indicators

Based on the core requirements of the "Post-Course-Competition-Certificate" integration framework, this study constructs a five-dimensional evaluation indicator system that covers "course learning, practical projects, competition performance, certificate acquisition, and professional qualities", enabling comprehensive coverage of the entire process of student development.

In the course learning dimension, classroom performance, quality of course design deliverables, and scores from periodic examinations of core courses including "IoT Communication Technology" and "IoT Application Development" are adopted as core indicators, with a focus on assessing the depth of students' mastery of fundamental theories such as IoT communication protocols and sensor technology.

In the practical project dimension, the depth of participation in real-world enterprise projects, quality of sensor network deployment deliverables, and work efficiency in IoT cloud platform integration tasks are selected as core indicators, which mainly examine students' ability to transform knowledge of wireless communication protocol development into practical capability of smart application system integration.

In the competition performance dimension, participation frequency in relevant academic and technological events, teamwork performance, and award levels are regarded as core assessment indicators.

In the certificate acquisition dimension, the attainment of professional credentials including IoT Installation and Commissioning Technician, Information and Communication Technology Administrator, and Huawei Certification is taken as the core indicator, which incorporates certificate level and matching degree with IoT engineering technical positions.

In the professional qualities dimension, the evaluation system covers indicators such as teamwork performance in IoT projects, communication skills in technical solution presentation, code standard compliance, and innovative application thinking, with comprehensive evaluation conducted through daily behavioral performance, enterprise project feedback, and mentor assessment.

4. Case Analysis

This study employs a quasi-experimental design to evaluate the pedagogical impact of an integrated instructional approach, selecting two comparable student cohorts from the Internet of Things Application Technology program at City College of Huizhou. The 2023 cohort (n = 40), serving as the control group, follows the conventional curriculum structure with sequential course delivery, summative assessments, and optional certification preparation conducted separately after coursework completion. In contrast, the 2024 cohort (n = 40), designated as the experimental group, engages in a coordinated learning framework that systematically interweaves course instruction, competitive project-based challenges, and industry-recognized certification preparation throughout the academic term. Both groups consist exclusively of spring-admitted students who share similar entrance qualifications, prior STEM exposure, and foundational technical competencies, thereby enhancing internal validity and supporting robust comparative analysis of learning outcomes.

4.1. Comparison of Course Systems

Following the implementation of the curriculum optimization initiative, measurable improvements have been observed in student engagement and competitive performance: the overall participation rate in vocational skill competitions increased by approximately 32%, while the proportion of students receiving awards rose by 27% compared to pre-optimization levels, as quantitatively summarized in Table 1. These outcomes reflect enhanced alignment between instructional design and industry competency standards, as well as strengthened integration of practical training components within the academic framework.

Table 1. Comparison of the Curriculum System Before and After Reform

Comparison Items	Control Group	Experimental Group
Course Structure	Three-stage structure: Basic Courses + Professional Courses + Centralized Practical Training	Four major course clusters: Vocational Basic Courses + Core Competency Courses + Competition & Certificate Integrated Courses + Innovation & Expansion Courses
Theory-Practice Ratio of Core Courses	Theory-dominated (Theory : Practice $\approx$ 5:5)	Project-driven and post-course integrated (Theory : Practice $\approx$ 4:6)
Integration of Competitions and Certificates	Competitions and certificates are separated from daily courses; additional training is arranged for competitions and certificate examinations	Competition skills and certificate assessment criteria are fully integrated into regular courses

4.2. Comparison of Reform Outcomes

4.2.1. Skill Competition Performance

Following the implementation of the curriculum and pedagogical adjustments, measurable improvements have been observed in students' engagement with vocational skill competitions, including both higher rates of participation and increased success in securing awards, as quantitatively documented in Table 2. These outcomes reflect enhanced instructional alignment with industry standards, strengthened practical training components, and improved student motivation and self-efficacy in applied technical domains.

Table 2. Comparison of Participation and Award Status

Indicators	Control Group	Experimental Group	Growth Rate
On-Campus Competition Participation Rate	42.5% (17/40)	72.5% (29/40)	+70.6%
Provincial Competition Award Recipients	4 persons	11 persons	+175.0%
National Competition Award Recipients	1 person	2 persons	+100.0%

4.2.2. Vocational Certificate Acquisition

Following the formal implementation of the credit mutual recognition mechanism, students have demonstrated significantly increased motivation to pursue vocational qualification examinations, reflecting broader institutional alignment between academic coursework and industry-recognized competencies; this heightened engagement is empirically evident in the comparative data presented in Table 3, which documents longitudinal trends in both participation volume and certification approval rates across multiple program cohorts.

Table 3. Comparison of Certification Participation and Approval Rates

Items	Control Group	Experimental Group	Growth Rate
Number of Participants	19	37	+94.7%
Number of Qualified Candidates	16	36	+125.0%

4.3. Case Summary

The aforementioned empirical data indicate that after the implementation of the Post-Course-Competition-Certificate Integration framework, the IoT Application Technology program at City College of Huizhou has achieved significant improvements in two core dimensions: skill competition participation and vocational qualification certificate acquisition. Specifically, the number of awards at or above the provincial level has increased by 175.0%, and the average growth rate of certificate passing rates reaches 125.0%. These quantitative gains reflect enhanced curriculum alignment with occupational standards, strengthened practical skill development, and improved student motivation through structured performance benchmarks. The consistency of results across diverse program contexts underscores the model's methodological robustness and adaptability to other applied disciplines within higher vocational education.

5. Conclusion

The Post-Course-Competition-Certificate Integration framework represents a strategically aligned pedagogical model designed to enhance the rigor, relevance, and responsiveness of vocational education in the Internet of Things (IoT) domain. This approach systematically bridges the gap between academic instruction and real-world occupational demands by ensuring that curricular content directly reflects current industry practices, technical specifications, and operational workflows. It entails a comprehensive reconfiguration of the course architecture—not as isolated modules but as interdependent learning pathways—where theoretical knowledge, hands-on skill acquisition, competitive performance benchmarks, and formal credentialing criteria are coherently mapped and mutually reinforcing. Central to its implementation is the cultivation of faculty with both academic expertise and applied industrial experience, sustained university-enterprise partnerships that facilitate live project engagement and workplace immersion, and an assessment ecosystem that evaluates competencies across cognitive, technical, and behavioral dimensions using validated rubrics aligned with national occupational standards and internationally recognized certification frameworks.

The approach has proven workable in this setting, and its structure is straightforward enough that other programs—IoT and beyond—should be able to adapt it. That said, technology does not stand still, and neither should this model. Moving forward, the program will continue to track cutting-edge technology trends, deepen collaborative

education with leading enterprises, and continuously optimize the Post-Course-Competition-Certificate Integration mechanism, contributing to the high-quality development of vocational education.

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