Research on Implementation Strategies of Stratified Teaching for Higher Vocational IoT Major from the Perspective of Post-Course-Competition-Certificate

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Abstract. Based on the comprehensive education model of Post-Course-Competition-Certificate (PCCC) integration, this paper systematically explores the implementation mechanism and paths of stratified teaching for the Internet of Things (IoT) Application Technology major in higher vocational colleges. By analyzing the internal logical relationship among posts, courses, competitions and certificates, this paper reveals the deep coupling mechanism between PCCC integration and stratified teaching in terms of ability gradients and evaluation dimensions. Five practical implementation strategies are summarized and elaborated, including constructing a progressive modular curriculum system of "**1+N**", developing granular and three-dimensional teaching resource ecosystem, operating boundary-crossing collaborative innovation studios, building a gradient competition-driven chain, and reconstructing a diversified closed-loop evaluation system. Practical results show that the proposed strategy system can effectively resolve the contradiction between teaching supply and demand under the background of diversified student sources, support personalized training and long-term development of students, and fully realize the goal of teaching students in accordance with their aptitude.

Keywords: Post-Course-Competition-Certificate Integration; Stratified Teaching; IoT Application Technology; Higher Vocational Education

1 Introduction

Against the background of higher vocational college enrollment expansion, student sources in higher vocational colleges have presented distinct diversification. Traditional teaching is confronted with new challenges: students from regular senior high schools, secondary vocational schools, retired military personnel, migrant workers and other groups differ greatly in knowledge foundation, learning ability, practical experience and career planning, which severely impacts the conventional unified teaching paradigm [1]. The National Vocational Education Conference held in 2021 clearly put forward the requirements of "**exploring the integration of Post-Course-Competition-**

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Certificate" and "**conducting classified teaching and teaching students in accordance with their aptitude for different student groups**" [2]. In the same year, the General Office of the Communist Party of China Central Committee and the General Office of the State Council jointly issued the Opinions on Promoting the High-Quality Development of Modern Vocational Education. The document emphasizes that vocational education should "**serve all people and teach students in accordance with their aptitude**", "**improve the comprehensive education mechanism of Post-Course-Competition-Certificate integration**", design and develop courses in line with actual production and job requirements, build modular and systematic practical training curriculum systems, and enhance students' practical capabilities [3]. To further advance PCCC integrated education, the one-size-fits-all teaching mode must be abandoned, and individual differences among students should be fully valued in higher vocational colleges [4].

Therefore, exploring solutions to the problems caused by diversified student sources, integrating the PCCC comprehensive education mechanism into regular teaching, and implementing stratified and classified teaching are of great significance for improving the training quality of high-skilled talents and precisely connecting with industrial demands. Targeting the current situation of diversified student sources in higher vocational colleges and combining with the actual development of the IoT Application Technology major, this paper deeply analyzes the coupling logic between PCCC integration mode and stratified teaching system, explores practical paths to teach students in accordance with their aptitude and facilitate their personalized growth, and provides references for the innovation of talent training modes for other majors in higher vocational colleges.

2 Coupling Mechanism between Post-Course-Competition-Certificate Integration and Stratified Teaching

The PCCC integrated model represents an innovative training mode exclusively developed for vocational education, which combines professional job positions, in-class curricula, vocational skill competitions and industry certification systems as a whole[5,6]. Hierarchical classification of industrial job clusters, progressive difficulty settings of competitions and qualification certificates, as well as flexible modular curriculum units, jointly form objective assessment criteria to underpin the delivery of stratified teaching activities.

2.1 Structural Coupling: Tiered Job Requirements and Differentiated Student Competencies

Vocational posts constitute the foundational anchor of vocational talent cultivation, establishing core standards for personnel development[5,7-8]. IoT industry job clusters are hierarchically categorized into three tiers: basic equipment operation and maintenance, intermediate system integration, and high-end application development. These inherent hierarchical attributes provide practical references for designing corresponding stratified teaching levels (foundational, advanced, and innovative training).

Higher vocational learners exhibit diverse educational backgrounds, resulting in uneven knowledge reserves, learning capacities, practical experience, and career plans. Drawing on Lev Vygotsky's Zone of Proximal Development theory, teaching content is structured to slightly surpass learners' current abilities while remaining accessible with appropriate guidance. Innovative-tier students oversee team coordination, task scheduling, and routine technical troubleshooting; advanced-tier learners focus on hardware connection and basic code modification; foundational-tier students complete imitative operations (e.g., equipment wiring, standardized code debugging). This progressive model fosters incremental confidence and capability building. The core of structural coupling lies in aligning hierarchical job requirements with students' differentiated abilities, enabling learners with varied academic foundations to define clear career objectives.

2.2 Carrier Coupling: Adaptive Curriculum Modules and Diversified Learning Routes

Curriculum systems serve as the primary vehicle for talent cultivation in higher vocational colleges, playing a pivotal role in stratified teaching implementation. Optimizing curriculum design remains a core task in advancing Post-Course-Competition-Certificate (PCCC) integrated education[4,9]. Guided by PCCC principles, traditional curricula are restructured into fine-grained, independent functional modules. These modules adapt flexibly to evolving job demands, offering diversified learning pathways for all students.

Modular curriculum design adheres to the logic of content decomposition and recombinant combination, breaking the rigid structure of traditional courses by dividing content into discrete micro-competency units. Each unit features clear assessment criteria and training objectives, supporting flexible combination based on individual learning needs. Howard Gardner's Multiple Intelligences theory highlights unique strengths across learning domains; refined modular courses enable students to select pathways aligned with their advantages, continuously enhancing professional skills and comprehensive literacy. The synergy of modular teaching carriers and flexible learning routes achieves dynamic alignment between educational supply and personalized learning demands.

2.3 Standard Coupling: Progressive Certifications and Contests as Stratified Evaluation Benchmarks

Skill competitions orient daily teaching, while vocational qualification certificates validate learning outcomes[5,10]. Current vocational skill grading systems (junior, intermediate, senior) cover basic standardized operations to advanced logic design and program development, providing quantifiable evaluation benchmarks for stratified teaching.

Competitions at campus, provincial, and national levels feature progressively increasing difficulty: campus contests offer foundational learners a universal platform to verify daily learning; provincial events serve as practical training grounds for advanced students to strengthen resilience and teamwork; national high-level competitions enable innovative learners to overcome technical bottlenecks. As key external indicators of vocational education quality, competitions and certificates form integral components of multi-dimensional evaluation systems. The integration of tiered competition/certification standards with hierarchical evaluation rules delivers industry-recognized assessment frameworks for stratified teaching practice.

3 Implementation Strategies of Stratified Teaching for IoT Majors in Higher Vocational Colleges

3.1 Reconstruct Modular Curriculum System: Build a Progressive "1+N" System

A flexible and dynamically adjustable tiered modular curriculum based on PCCC integration lays a solid foundation for stratified teaching practice. Such curricula can adapt to the changing demands of the entire IoT industrial chain, provide personalized development paths for students with different learning foundations, and realize deep integration between talent cultivation and industrial job demands.

Traditional curricula adopt linear and fixed structural designs, which fail to meet the differentiated learning needs of diversified student groups. Centering on vocational post competencies and combining the linkage among posts, courses, competitions and certificates, the original teaching content is decomposed and reorganized. A tiered modular curriculum known as the "**1+N**" model is established for IoT Majors, and course content is dynamically updated to keep pace with evolving job requirements.The symbol "**1**" represents a unified basic professional platform available to all students, covering basic theoretical knowledge and core operational skills related to the three-layer architecture of IoT systems: perception layer, transmission layer and application layer. The symbol "**N**" stands for multiple differentiated modules corresponding to different vocational posts and career directions.

In actual teaching work, three sets of tiered teaching modules are developed to match hierarchical job capabilities, which correspond to foundational, advanced and innovative learning levels respectively. Modules for foundational learners are designed targeting basic IoT operation and maintenance posts, focusing on training students' standardized operational skills such as sensor installation, equipment commissioning and basic network configuration. Modules for advanced learners are oriented at system integration and commissioning job clusters, aiming to strengthen students' capabilities in system assembly, cloud platform application and program debugging. Modules for innovative learners take R&D assistant posts as the training orientation, cultivating advanced capabilities including complex network deployment, protocol analysis and optimization, application development and full-lifecycle IoT solution design. Combining a universal basic platform with differentiated post-oriented modules, the "**1+N**" tiered curriculum takes PCCC integration as its core logic and builds a complete training path from basic operational skills to innovative development capabilities.

3.2 Build Three-Dimensional Resource Ecosystem: Prioritize Granularity and Virtual-Physical Integration

Teaching resources are the material guarantee for the smooth implementation of stratified teaching. It is necessary to break the limitations of single universal textbooks and develop reconfigurable multi-dimensional resources to satisfy the learning demands of students at different levels.

This research constructs a multi-dimensional teaching resource system integrating virtual simulation and physical teaching materials, with refined content granularity as the core design principle. Traditional textbooks with linear content structures restrict students' independent learning and cannot adapt to diversified student groups. Under the framework of stratified teaching, new teaching materials are compiled following task-oriented design and progressive difficulty arrangement. Process-oriented loose-leaf textbooks are developed, while competition content and vocational certification assessment points are split into refined teaching resources and embedded into teaching modules of different levels. Textbook content is divided into basic task sheets for foundational learners, advanced challenge tasks for advanced learners and comprehensive project cases for innovative learners. Higher content granularity significantly improves the flexibility of stratified teaching arrangements.

VR and AR virtual simulation technologies are introduced into practical training sessions to deliver targeted guidance for different student groups. Foundational-level students practice sensor and gateway wiring in virtual environments and develop standardized operational habits with the help of real-time error reminder functions. Advanced learners build small-scale IoT network architectures and receive training in equipment matching and basic fault diagnosis within simulation scenarios. Innovative students complete overall project design on virtual platforms and verify functional effects with physical hardware devices. Each curriculum module is equipped with micro-lecture videos, operational guidelines and virtual simulation resources of different difficulty levels. Printed textbooks, virtual simulation platforms and cloud learning resources jointly form a complete three-dimensional resource system. The resource system provides strong support for stratified teaching, alleviates the shortage of practical training equipment under diversified teaching demands, and realizes precise resource supply for anytime, anywhere personalized learning.

3.3 Operate Collaborative Innovation Studios: Reconstruct Boundary-Crossing Teaching Organization

Fixed administrative classes, the traditional form of teaching organization, form physical barriers that hinder the implementation of stratified teaching. Teaching reforms that break class boundaries are essential to create diversified personalized learning paths.

Collaborative innovation workshops are built to reshape the form of teaching organization and realize cross-boundary teaching. Multiple workshops targeting different job directions are set up on campus, including IoT equipment operation and maintenance workshops and IoT system integration workshops. Each workshop is equipped with a tutor team composed of core professional teachers, enterprise instructors and outstanding senior student mentors. Core teachers deliver standardized online courses with the support of micro-lectures and virtual simulation tools for foundational and advanced learners, so as to raise the overall pass rate of vocational qualification examinations. Enterprise instructors introduce real industrial projects into workshop teaching and adopt the project-based apprenticeship mode. Immersive practical training connects classroom knowledge closely with actual job requirements for innovative-level students. Outstanding senior students set up competition support teams, pass down practical experience across grades via online collaborative tools, and build stable talent reserves for skill competitions.

All teaching activities adopt a dual-space mode combining online cloud platforms and offline physical workshops. Non-traditional student groups such as veteran learners finish theoretical learning and basic assessments online in their spare time before participating in offline practical training in workshops. Other students adopt a hybrid learning mode consisting of online preview, offline practical exploration and post-class online review. Teaching, learning, practical training and assessment are carried out seamlessly across online and offline spaces, realizing the comprehensive reconstruction of cross-boundary teaching organizations.

3.4 Establish Gradient Competition-Driven Chain: Construct Endogenous Motivation Mechanism

Skill competitions were once limited to a small number of outstanding students. By reforming this elite-oriented competition mode based on ability development, schools can build a sustainable learning motivation system, enabling every student to gain progress on suitable competition tracks.

A multi-level competition system covering on-campus, provincial, national and international events is established to stimulate students' self-improvement awareness. On-campus popular contests including C programming competitions and basic IoT skill contests arouse learning interest, consolidate basic knowledge and build learning confidence for all participants. Provincial IoT application competitions and vocational college skill contests improve advanced learners' teamwork and problem-solving capabilities, and promote the transformation from theoretical knowledge to practical job competencies. National innovation and entrepreneurship competitions as well as WorldSkills events are set as development goals for innovative learners, driving interdisciplinary collaborative research and cultivating comprehensive capabilities in technological innovation and project management.

Competition content is reorganized into tiered teaching tasks matching different learning levels, and clear phased development goals are formulated for students of all levels. The whole training process from interest cultivation to ability improvement and technological innovation integrates competition activities into daily teaching systems. This creates a positive cycle where contests promote learning effects, improve teaching quality and drive educational reform.

3.5 Reconstruct Diversified Evaluation System: Improve Closed-Loop Assessment for Stratified Teaching

A multi-dimensional and dynamically adjustable evaluation system matching student levels and curriculum characteristics can accurately assess learning effects, provide data support for teaching optimization, and assist students in individualized development and career planning.

A dynamic multi-angle evaluation mechanism is established to optimize the closed-loop workflow of hierarchical assessment, data feedback and adaptive teaching adjustment. Evaluation methods are formulated according to different curriculum types. Public basic courses mainly adopt written examinations to assess students' humanistic literacy and logical thinking abilities. Professional platform courses combine written tests and practical operations to examine both theoretical knowledge and hands-on skills. For job-oriented extended courses and core professional courses, vocational certification results and project performance are taken as core evaluation indicators to assess post competencies under simulated working scenarios.

The single-standard assessment mode is replaced by a multi-dimensional evaluation matrix. Researchers collect quantitative data such as competition award ratios, vocational certificate pass rates and skill assessment results to build a curriculum quality monitoring model. Clear rules are formulated for credit conversion of competition awards and vocational certificates, and a campus credit bank system is launched to realize flexible conversion between academic credits, skill credentials and competition honors. All assessment data are fed back to guide the iterative update of teaching strategies and curriculum content, forming a continuously optimized assessment closed loop. The newly built multi-dimensional hierarchical evaluation system breaks the limitations of traditional single-standard assessment methods and provides targeted support for students' career development.

4 Practical Reform and Effects

4.1 Sample Framework and Group Setup

The stratified teaching reform activity took all 180 students majoring in Internet of Things Application Technology from the author's institution as research subjects. All participants were separated into two independent experimental groups: a control cohort following conventional unified teaching schemes (2023 intake, total 90 participants) and an experimental cohort receiving tiered customized teaching (2024 intake, total 90 participants). Identical student source distribution and sample capacity were arranged for both groups. Each cohort contained 45 graduates from secondary vocational schools and another 45 students admitted via general senior high school pathways, among which 20 candidates enrolled through spring college admission examinations and 25 via summer college admission examinations. All comparative indicators adopted for cross-group contrast originated from academic records covering the initial four semesters of university study, which secured sufficient comparability between the two research groups.

4.2 Tier Partition Rules and Population Share of Differentiated Student Groups

(1) Criteria for Student Tier Classification

Upon conclusion of the first semester's instructional cycle, the research team conducted multi-dimensional evaluations of all 2024-intake students in the experimental cohort. Evaluation dimensions included comprehensive semester assessment results, one-on-one semi-structured career orientation interviews, and standardized psychological resilience test outcomes. Based on aggregated evaluation scores, learners were dynamically assigned to three hierarchical tiers: foundational, advanced, and innovative. Detailed tier classification thresholds and corresponding N-type modular training content are presented in Table 1.

Table 1. Classification Criteria and N-Module Count at Each Level

Tier Category	Aggregated Evaluation Score	Corresponding Job Group Targets	Supporting N Modular Training Content
Foundational Learning Tier	Less than 60 points	Basic IoT equipment operation and maintenance roles	Data acquisition and data processing, fundamental network deployment & maintenance, and relevant auxiliary training modules
Advanced Learning Tier	60 to 80 points	IoT system assembly, debugging and commissioning job positions	End-to-end IoT system integration, operation and development of IoT cloud service platforms, and matching practical training modules
Innovative Learning Tier	80 to 100 points	IoT application scheme design and software development posts	Full-set IoT system solution planning, custom application programming development, and extended comprehensive project modules

(2) Student Population Proportion within Each Learning Tier

Statistical analysis following the first-semester multi-dimensional evaluation revealed the initial distribution of the 90-student experimental cohort:

Foundational tier: 40 students (44.44%), including 30 secondary vocational graduates, 8 spring college admission candidates, and 2 summer college admission candidates;

Advanced tier: 36 students (40.00%), comprising 12 secondary vocational graduates, 10 spring college admission candidates, and 14 summer college admission candidates;

Innovative tier: 14 students (15.56%), consisting of 3 secondary vocational graduates, 2 spring college admission candidates, and 9 summer college admission candidates.

Throughout the entire reform implementation phase, all specialized practical training for innovative-tier learners was conducted within cross-disciplinary collaborative innovation studios.

4.3 Reform Implementation Effects and Quantitative Statistical Verification

Quantitative Analysis of Vocational Qualification Certification Gains.

Significant disparities in credential pass rates were observed between the two research cohorts during standardized assessments for vocational certificates (e.g., Information and Communication Network Operator, Computer Programmer). Table 2 presents grouped statistics on certification acquisition ratios by student admission background. Within the stratified teaching experimental cohort, 38 students successfully obtained relevant vocational qualifications, with breakdowns as follows: 10 from the foundational tier, 20 from the advanced tier, and 8 from the innovative tier.

Table 2. Cross-Group Comparison of Vocational Qualification Certificate Acquisition Proportions

Student Admission Background Category	Conventional Teaching Control Group	Stratified Teaching Experimental Group	Relative Growth Ratio
Secondary Vocational School Graduates	13.3% (6/45)	26.7% (12/45)	+13.4%
Spring College Entrance Examination Applicants	20.0% (4/20)	45.0% (9/20)	+25.0%
Summer College Entrance Examination Applicants	32.0% (8/25)	68.0% (17/25)	+36.0%
Overall Aggregated Sample	20.0% (18/90)	42.2% (38/90)	+22.2%

Statistical significance testing procedures targeting the inter-group gaps of certification acquisition ratios are outlined as follows:

Calculation of the chi-square test statistic (χ^2):

$$\chi^2 = \sum \frac{(O-E)^2}{E} = 10.368$$

Confirmation of degrees of freedom and corresponding p-value:

The formula df=(2-1)\times(2-1) yields a degree of freedom equal to 1. Under the chi-square value of 10.368, the matched p-value equals 0.0013, which sits below the 0.01 significance threshold and points to an extremely prominent statistical difference between groups.

Calculation of Cramer's V effect size indicator:

$$V = \sqrt{\frac{\chi^2}{N \times \min(R-1, C-1)}} = \sqrt{\frac{10.368}{180 \times 1}} = \sqrt{0.0576} \approx 0.240$$

Academic conventions classify effect sizes between 0.1 and 0.3 as medium, demonstrating that stratified teaching exerts a stable moderate positive impact on students' vocational certificate acquisition.

Measurable Gains Observed from Vocational Skill Competitions.

To conduct precise, multi-faceted evaluations of reform effectiveness, this study categorized skill competitions into two independent statistical dimensions: campus-level intramural contests and provincial-level (and above) competitive events. Relevant comparative data are compiled in Table 3. The stratified teaching experimental cohort accumulated a total of 68 valid competition award records: Winners of campus-level competitive activities: 22 foundational-tier students, 19 advanced-tier students, 9 innovative-tier students; Winners of provincial-level competitive tournaments: 10 advanced-tier students, 8 innovative-tier students.

Table 3. Comparative Statistics of Competition Award Performance Between Two Teaching Cohorts

Competition Level	Student Source	Traditional Group	Stratified Group	Growth Rate
College-level Competition	Secondary Vocational Graduates	17.8% (8/45)	35.6% (16/45)	+17.8%
	Spring College Entrance Candidates	35.0% (7/20)	75.0% (15/20)	+30.0%
	Summer College Entrance Candidates	40.0% (10/25)	76.0% (19/25)	+36.0%
Aggregated Campus Contest Total		27.8% (25/90)	55.6% (50/90)	+27.8%
Provincial-level Competition	Secondary Vocational Graduates	2.2% (1/45)	6.7% (3/45)	+4.5%
	Spring College Entrance Candidates	10.0% (2/20)	25.0% (5/20)	+15.0%
	Summer College Entrance Candidates	16.0% (4/25)	40.0% (10/25)	+24.0%
Aggregated Provincial Contest Total		7.8% (7/90)	20.0% (18/90)	+12.2%

(1) Significance inspection targeting inter-group gaps in campus contest award acquisition ratios

Statistical computation based on collected sample data generates a chi-square value of χ^2=44.012 with degrees of freedom fixed at 1. The corresponding p-value falls below 0.0001, marking an extremely significant statistical distinction across cohorts. The computed Cramer's V value reaches 0.494, categorized as a large effect size. This numerical outcome proves that stratified tiered teaching greatly lifts student engagement levels and overall award-winning probabilities in intramural skill competitions.

(2) Significance inspection targeting inter-group gaps in provincial contest award acquisition ratios

Dataset-based computation produces a chi-square statistic of χ^2=5.620 under df=1. The corresponding p-value stands at 0.0178, a figure smaller than the standard 0.05 significance cut-off and verifying statistically meaningful disparities between two research groups. The calculated Cramer's V value equals 0.177, falling within the medium effect scope of $0.1 < V < 0.3$. Such results demonstrate that the joint deployment of tiered instruction and cross-disciplinary innovation studio training effectively offsets the learning disadvantages carried by underperforming student subgroups, while generating steady improvements on participants' competitiveness in high-standard provincial vocational contests.

5 Conclusion

This set of teaching strategies takes modular curriculum restructuring as the core reform direction, and is supplemented by fine-grained teaching resources, collaborative innovation workshops, tiered competition chains and multi-dimensional closed-loop evaluation mechanisms. Practical application results show that these measures effectively increase vocational certificate pass rates and competition award rates, and resolve teaching contradictions caused by diversified student groups in IoT Majors. Stratified teaching schemes formulated according to students' actual abilities fully reflect the value of individualized education, and provide replicable practical experience for talent training reform of all majors in higher vocational colleges. With the continuous development of digital and intelligent technologies, stratified teaching will evolve into intelligent adaptive learning modes, creating more scientific and comprehensive implementation paths for individualized instruction in vocational education.

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