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Research on the Quality Assurance and Evaluation Feedback Mechanism of the Segmented Talent Cultivation through the Integration of Higher Vocational Education and Undergraduate Education

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Abstract: The segmented cultivation program that integrates higher vocational education with undergraduate education is an important institutional arrangement for improving the modern vocational education system and cultivating high-level technical and skilled talents. Its sustainable development relies on a scientific, systematic, and closed-loop quality assurance and evaluation feedback mechanism. This paper examines the entire integrated education process, first identifying the primary quality challenges in five dimensions: cultivating objectives, curriculum system, faculty development, evaluation standard, and school-enterprise collaboration. Subsequently, drawing upon stakeholder coordination theory and total quality management, it constructs a dual-drive model comprising a collaborative quality assurance system and an assessment feedback improvement system. Finally, it elaborates on operational mechanisms across five dimensions: standard setting, process management, multidimensional evaluation, data governance, and continuous improvement, and policy recommendations are proposed. The findings offer valuable reference for educational administrative authorities, institutions, and industry enterprises in refining the integrated education system.

Keywords: Segmented integrated education; Quality dilemma; Dual-drive model; Collaborative pathway; Policy recommendation

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1. Introduction

The 20th National Congress of the Communist Party of China proposed "coordinating the collaborative innovation of vocational education, higher education, and continuing education" [1–3], calling for the establishment of a modern vocational education system that is vertically integrated and horizontally interconnected. The segmented cultivation program that integrates higher vocational education with undergraduate education (hereafter referred to as integrated education) facilitates upward pathways for technical and skilled personnel through coordinated academic systems, interconnected curricula, and mutual recognition of credits. This constitutes a vital institutional arrangement for refining the structure of vocational education and optimizing the higher education landscape [4–6]. Integrated education aims to cultivate high-caliber technical and skilled personnel [7], embodying both the distinctive features of vocational education and the advanced requirements of undergraduate education. It plays an irreplaceable role in serving national strategies such as building a manufacturing powerhouse and a digital China.

While expanding in scale, integrated education has revealed quality concerns such as inadequate vertical alignment of cultivating objectives, redundant or missing curriculum systems, impeded two-way faculty mobility, singular and outdated evaluation standards, and superficial school-enterprise collaboration [8–10]. Failure to systematically address these contradictions will lead to a mismatch between talent cultivation and industrial demands, thereby undermining the social recognition of integrated education.

This paper centers on the core question of how to establish a scientific, systematic, and closed-loop quality assurance and evaluation feedback mechanism. Drawing upon stakeholder coordination theory and total quality management theory, it constructs a dual-drive model comprising a collaborative quality assurance system and an assessment feedback improvement system. The operational mechanisms are elaborated across five dimensions: standard setting, process management, multidimensional evaluation, data governance, and continuous improvement. Ultimately, policy recommendations are proposed for government bodies, educational institutions, enterprises, and third parties.

2. Five-dimensional quality dilemma of integrated education

2.1. Challenges in cultivating objectives: Misalignment in vertical continuity and ambiguity in horizontal positioning

In the vertical dimension, the core expression of the higher vocational stage is proficient operation and standardized execution, while the undergraduate stage directly jumps to systematic analysis and innovative solutions. This gap omits transitional competencies like process optimization, parameter tuning, and fault diagnosis, leaving students confronting a cognitive gap of skills, technology, and engineering upon advancing to undergraduate studies. In the horizontal dimension, the same discipline across different regions and institution types exhibits fragmented educational objectives due to divergent industrial structures and institutional positioning. This results in the coexistence of multiple discourses, such as discrete manufacturing versus process manufacturing and technical integration versus skill combination. This lack of cross-regional and cross-institutional benchmarks, coupled with difficulties in precise mapping to professional qualification standards, ultimately results in graduates possessing locally adapted yet globally drifting competency structures. This leaves enterprises at a loss regarding hiring criteria and students navigating unclear career development pathways.

2.2. Challenges in the curriculum system: Content redundancy, inconsistent standards, and outdated updates

The same technical course may cover equipment operation and safety protocols exhaustively at the vocational college level, only to be repeated with similar case studies at the undergraduate level, leading to redundant teaching hours and student fatigue. Two sets of teaching standards: the professional teaching standards for higher vocational education and the national teaching quality standards for undergraduate education, operate independently in terms of knowledge depth, skill dimensions, and credit weight, frequently encountering bottlenecks during mutual recognition and conversion. Meanwhile, technological iteration cycles have compressed to annual intervals or shorter, yet course updates persist with a triennial or quadrennial major revision rhythm. This results in classroom content lagging behind industrial practice, leaving students facing the awkward situation of one does not do what one has learned before graduation. The compounding effects of these three bottlenecks not only squander valuable teaching resources but also undermine the overall efficacy and societal credibility of integrated education.

2.3. Challenges in the faculty development: Barriers to two-way mobility and imbalanced competency structures

Higher vocational teachers possess first-hand technical skills yet struggle to transition into undergraduate classrooms due to academic qualifications and research metrics gaps. Conversely, undergraduate teachers have a strong theoretical foundation but lack practical industry experience, rendering them ill-equipped for vocational training scenarios. Current systems for professional title evaluation and performance appraisal prioritize publications and research projects over technical achievements and pedagogical innovation. Consequently, even engineers possessing cutting-edge production line expertise struggle to gain the admission ticket required for university teaching qualifications. Meanwhile, the practice of college teachers going to enterprises for training often becomes a mere formality due to obstacles such as teaching duties, assessment, and remuneration. Consequently, both the dual-qualified teachers in higher vocational education and the academic teachers in undergraduate education remain confined within their respective identity labels, unable to form a composite capability chain linking technology, teaching, research and development. This results in a structural disconnect in the talent specifications cultivated, creating a gap between advanced theoretical knowledge and practical field experience.

2.4. Challenges in evaluation standard: Single dimension, outcome orientation, and delayed feedback

The current system overly relies on final written examinations and one-time skill assessments, treating scores as the sole metric. This approach overlooks students' process-based performance in tackling complex engineering problems, their innovative potential in teamwork, and their value judgments regarding professional ethics. Evaluation outcomes are used solely to determine whether students pass, rarely feeding back into teaching design or classroom improvement, creating a closed-loop disconnect where it is over once the exam is over. Compounded by protracted data collection cycles and sluggish feedback channels, teachers receive analytical reports only after courses conclude and students depart, preventing timely corrective action. Improvement plans are thus deferred to subsequent cohorts. This triple burden of singular metrics, outcome-centricity, and delayed feedback perpetually lags behind industrial technological evolution and student developmental rhythms, ultimately undermining the precision and credibility of talent cultivation.

2.5. Challenges in school-enterprise collaboration: Fragmented cooperation, insufficient depth, and lack of incentives

School-enterprise collaboration has long been confined to the three-piece set of unveiling plaques, equipment donation, and internship reception. Despite a stack of project agreements, there is little genuine co-building of curricula, co-training of faculty, or co-management of assessment. Enterprise technicians occasionally enter the classroom, but often appear briefly as guest speakers, struggling to engage deeply in setting cultivating objectives or participating throughout the teaching process. Current fiscal policies fail to provide targeted compensation for enterprises' investments in human resources, technology, and facilities. Costs cannot be included in research and development expenses, and tax incentives are difficult to implement, resulting in enterprises' efforts not being rewarded. The convergence of fragmented collaboration, superficial engagement, and absent incentives ultimately renders school-enterprise collaboration a ceremonial handshake rather than a blood and flesh hand in hand. Consequently, integrated education loses access to the most vital technical nourishment from industrial practice and the most authentic evaluation benchmarks.

3. Theoretical framework: CQAS-AFIS dual-drive model

3.1. Stakeholder synergy theory

Stakeholder synergy theory conceptualizes integrated education as a multi-actor collaborative ecological theatre [11] (as illustrated in **Figure 1**). Six types of stakeholders, including government, higher vocational colleges, undergraduate universities, industries and enterprises, students and parents, and third parties, each bring distinct value aspirations and resource endowments. The government employs public finance and policy instruments to pursue educational equity and industrial alignment. Vocational colleges require distinctive educational offerings and employment rates to bolster their reputation. Undergraduate universities aspire to enhance the educational level through applied transformation. Industries and enterprises hope to obtain high-level technical and skilled talents who are ready to use at a low cost. Students and parents prioritize educational return on investment and career advancement channels. Third-party organizations strive to expand market influence through certification and evaluation. This theory emphasizes that no single entity can independently accomplish the complex task of talent cultivation. It necessitates institutional design to achieve a collaborative governance structure characterized by shared power, shared responsibility, and shared benefits. On the one hand, laws, charters, and agreements must clearly delineate the rights and responsibilities of all parties to prevent free-riding and opportunism. On the other hand, multiple incentive measures such as finance, taxation, reputation, and information are used to promote resource complementarity and risk sharing, ultimately forming a dynamically balanced and continuously evolving cooperative network. This elevates integrated education from project collaboration to a community with a shared future.

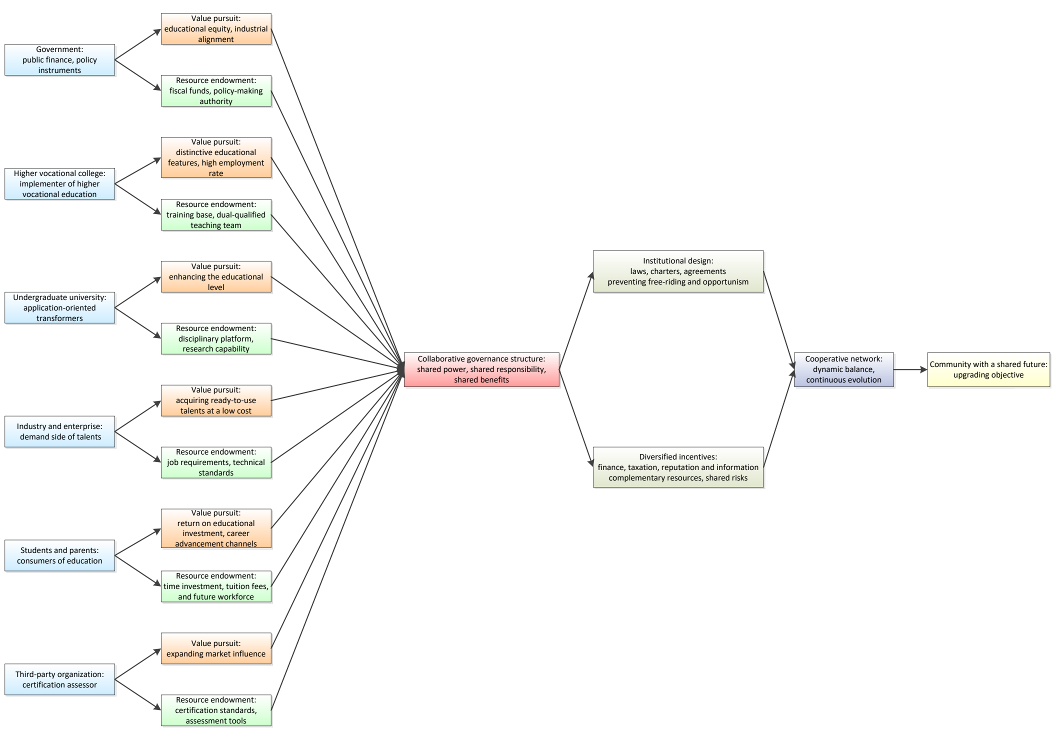

Figure 1. Ecological theatre of integrated education under stakeholder synergy theory

3.2. Total quality management (TQM)

Total quality management (TQM) views integrated education as an end-to-end quality chain [12], placing the voice of the customer (industry and student demands) at the core. Through a systemic thinking encompassing full staff, full processes, full elements, and multiple methods, it incorporates all links such as enrollment entry, course implementation, faculty development, school-enterprise collaboration, and graduate exit into the PDCA closed loop (as illustrated in **Figure 2**). The Plan stage sets measurable cultivating objectives based on technological iteration and job competency models. The Do stage ensures teaching practice evaluation operates in accordance with specifications through standardized processes and digital platforms. The Check stage employs real-time data and third-party audits for early-warning diagnostic deviation. The Act stage solidifies improvement measures into new standards via course micro-updates, teachers' retraining, and redesigned school-enterprise collaboration [13]. TQM not only provides methodology but also fosters a quality culture: breaking down organizational boundaries between institutions, enterprises, and government, allowing teachers, engineers, managers, and students to become members of the quality community. This enables talent development specifications to align seamlessly with industry demands through continuous improvement.

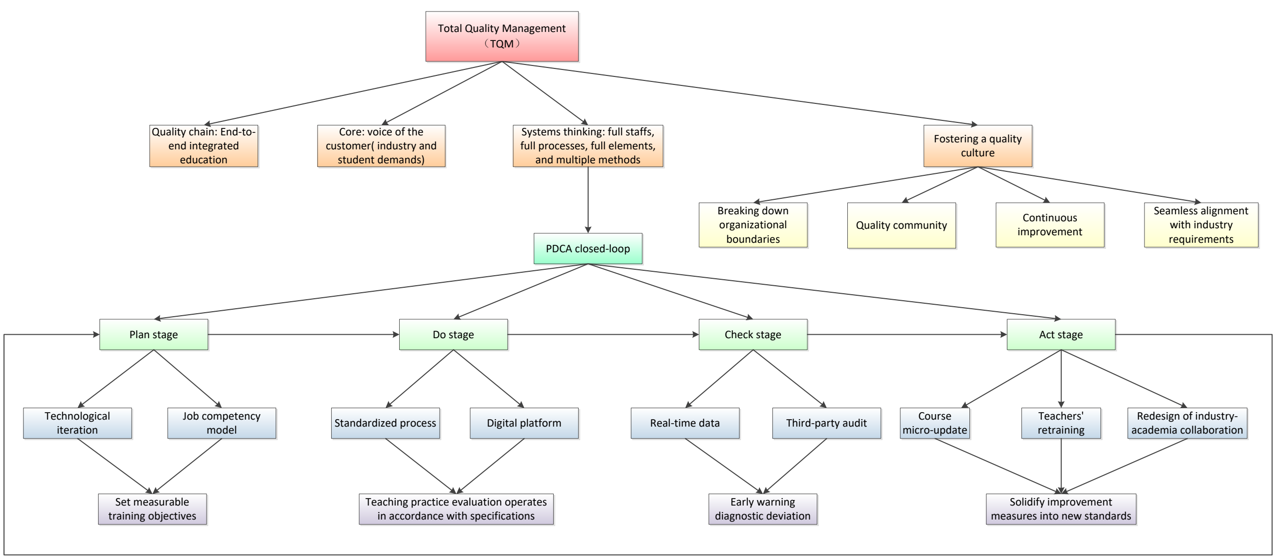

Figure 2. Schematic diagram of talent cultivation quality closed-loop under total quality management (TQM) perspective

3.3. Dual-drive model

3.3.1. Collaborative Quality Assurance System (CQAS)

The Collaborative Quality Assurance System (CQAS) operates through government coordination, industry leadership, school-enterprise collaboration, and third-party certification. It establishes a three-tier closed-loop framework:

(1) Top tier: Standard development consortium

(2) Middle tier: Process management consortium

(3) Bottom tier: Resource assurance consortium

The top tier involves education authorities, industry technical committees, and higher education institutions jointly developing occupational competency frameworks, curriculum standards, faculty benchmarks, and evaluation standards to ensure vertical alignment and horizontal coherence. The middle tier employs an intelligent management platform to monitor teaching, practical training, and corporate feedback data in real time, triggering early warnings and collaborative interventions. The bottom tier integrates government funding, corporate equipment, institutional teaching resources, and third-party services into a sustainable contractual framework encompassing investment, sharing, returns, and exit. This enables integrated education to achieve co-governance of quality, shared risk-bearing, and mutual benefit through the tripartite linkage of standards, processes, and resources.

3.3.2. Assessment Feedback Improvement System (AFIS)

The Assessment Feedback Improvement System (AFIS) is centered around four closed loops of data, diagnosis, decision, and tracking. It aggregates real-time, multi-source heterogeneous data from academic performance, practical training, enterprises, and third-party evaluations. After cleansing and anonymization, it generates red-yellow-green warning diagrams. The system then initiates cross-stakeholder diagnostic meetings, decomposing root causes of deviations into four domains: curriculum, faculty, resources, and collaboration. This generates actionable improvement work orders with assigned responsibilities, timelines, and resource packages. Post-implementation, the platform continuously tracks student growth trajectories, corporate satisfaction, and course attainment rates. It automatically quantifies outcomes for feedback loops, triggering iterative standard refinements to achieve a spiral of quality enhancement and institutionalized memory within integrated education.

3.3.3. Dual-drive coupling

The dual-drive coupling mechanism centers on the integrated education intelligence platform, establishing real-time interconnection between the CQAS standards repository and the AFIS data engine. When the platform detects course repetition rates exceeding thresholds or declining corporate satisfaction, it immediately triggers the CQAS standards development consortium to initiate revision procedures while simultaneously pushing specialized diagnostic tasks to AFIS. Once an improvement proposal is validated by AFIS as effective, it is immediately consolidated back into CQAS as a new standard, achieving a sub-second closed-loop between standards, data, and improvements. Government, institutions, enterprises, and third parties share a dynamic dashboard within the same interface. This prevents standards from becoming rigid while avoiding data stagnation, enabling integrated education to continuously resonate with industry frontiers through a rhythm of front-wheel steering and rear-wheel drive.

4. Operational mechanism: Five-dimensional collaborative pathway

4.1. Standard setting: Tiered classification and dynamic iteration

Standard setting employs a three-tier mapping model of industry demands, capability units, and learning outcomes. Industry technical committees first distil core occupational competencies from job clusters, then progressively decompose these into measurable indicators across four tiers: operation, debugging, optimization, and innovation. Subsequently, joint school-enterprise curriculum workshops translate these competency metrics into modularized course components, credit hours, and evaluation methods for seamless progression between higher vocational and undergraduate education. It implemented an agile mechanism of trigger, validation, revision, and publication to achieve annual fine-tuning and biennial comprehensive revisions, ensuring curriculum standards resonate with technological evolution, equipment upgrades, and regulatory updates. This establishes a tiered, categorized, and dynamically iterated closed-loop standards chain.

4.2. Process management: Digitalization, precision, and early warning

Process management is achieved through the approach of one map, one chain, and one network to realize digitalization, precision, and early warning. The entire cycle of the integrated education program is divided into five main processes: enrollment and admission, course study, job internship, graduation design, and employment tracking. These processes are further refined into twenty-one secondary nodes and sixty-seven quality control points. All are embedded within an intelligent management platform, which collects real-time data on classroom engagement, practical training logs, employer evaluations, and certification attainment. The platform automatically generates red, amber, and green alerts based on predefined thresholds. Should course pass rates dip, internship deadlines lapse, or corporate satisfaction decline, notifications are instantly dispatched to tutors, counsellors, industry mentors, and administrators. This triggers collaborative intervention, resource reallocation, and pedagogical refinement, establishing a traceable, reviewable, and optimizable closed-loop management system.

4.3. Multidimensional evaluation: Ability-oriented, process-embedded, and outcome-shared

Multidimensional evaluation focuses on the growth of abilities and runs through the entire process of learning, doing, and creating. First, establish a four-dimensional metric system of knowledge, skills, literacy, and innovation, with the weights dynamically adjusted as the educational stage progresses. Second, embedding diverse tools such as project work orders, digital profiles, and workplace observations to record students' task completion, collaborative performance, and reflective depth in real time. Thirdly, blockchain evidence is used to ensure that the data cannot be tampered with. The evaluation results are immediately fed back to teachers to improve teaching, to enterprises to optimize positions, and to students to generate personalized growth reports. These results directly influence scholarships, direct university admission, and starting salaries, creating a virtuous cycle where evaluation drives improvement, outcomes are shared, and value addition is an incentive.

4.4. Data governance: Three-tier architecture of the education big data center

The education big data center adopts a three-tier architecture: collection, governance, and utilization. The collection layer interfaces with institutional academic systems, enterprise MES platforms, third-party certification bodies, and employment portals via standardized protocols, aggregating real-time raw data across academic, production, and certification dimensions. The governance layer employs a hybrid data lake and warehouse model to perform cleansing, noise reduction, anonymization, and rights verification, establishing unified master data and a tiered permission system to ensure single-source data and end-to-end traceability. The application layer builds a quality dashboard for administrators, presenting real-time program alerts, resource efficiency, and industry alignment. It delivers teaching diagnostics and improvement recommendations to faculty, while generating competency radars and growth pathways for students, achieving a data-driven closed-loop integration of decision-making, teaching, and learning.

4.5. Continuous improvement: Institutionalization of the PDCA cycle

Continuous improvement is embedded through institutionalizing the PDCA cycle into governance protocols, enabling a four-year rolling cycle of Plan-Do-Check-Act. Every spring, the quality committee revises training programs and curriculum standards based on industry white papers and data diagnostics. In summer, the dual-track program of teacher enterprise practice and enterprise mentor residency is launched. In autumn, teaching supervisors and third-party agencies jointly conduct classroom observations, project evaluations, and employer interviews, uploading results in real time to the smart platform. In winter, an improvement conference is convened to issue rectification orders for programs under red, yellow, or green alerts. Successful practices are codified into new standards and processes, automatically triggering the next PDCA cycle. This ensures the integrated education program maintains zero-delay alignment with industry frontiers through continuous spiral advancement.

5. Policy recommendations

5.1. Government: Three-dimensional coordination of legislation, finance, and information

The government shall inject institutional momentum into integrated education through tripartite synergy in legislation, finance, and information. At the legislative level, incorporate enterprise participation in curriculum standard development, two-way faculty mobility, and quality evaluation into a dedicated chapter of the implementing regulations of the vocational education law, clarifying the delineation of rights and responsibilities between schools and enterprises alongside dispute resolution mechanisms. At the financial level, establish a special project for improving the quality of integrated education, offering pre-tax deductions and post-event subsidies for corporate expenditure on curriculum co-development, training base upgrades, and teacher training. Institutions achieving ISO educational quality certification shall receive additional per-student funding allocations. At the information level, a national quality monitoring platform for integrated education programs will be developed, providing real-time access to core indicators such as program early warnings, curriculum alignment, and enterprise satisfaction. This fosters transparent quality and public oversight, creating a policy loop where regulatory rigor, financial leverage, and data transparency synergize.

5.2. Institution: Three-dimensional transformation in organization, faculty, and curriculum

Institutions shall implement multidimensional reforms centered on organizational restructuring as the vanguard, faculty transformation as the fulcrum, and curriculum system redesign as the core. At the organizational level, establish a quality committee for integrated education comprising representatives from higher vocational colleges, undergraduate institutions, enterprises, and third-party agencies. Implement joint decision-making with veto power to dismantle inter-institutional barriers. At the faculty level, implement a parallel system of dual-appointed professors and industry professors. Undergraduate faculty undertake one-year placements in enterprises, while vocational college staff undertake six-month advanced studies at undergraduate institutions. Professional title evaluations grant equal weight to enterprise practice credits, technological innovation achievements, and teaching research. At the curriculum level, a course supermarket plus credit bank system is developed, permitting students to select modules across institutions and enterprises. Core courses undergo micro-updates every two years to align with evolving industrial technologies, fostering a new ecosystem of collaborative governance, shared faculty resources, and flexible curricula.

5.3. Enterprise: Deep engagement, resource openness, and talent reservation

Enterprises embed integrated education within industrial ecosystems through a three-pronged strategy of deep engagement, resource openness, and talent reservation. Deep engagement involves establishing a dual-track system where enterprise mentors are stationed on campus while college teachers are embedded within enterprises. Technical specialists maintain a permanent presence in classrooms and training centers, participating throughout in curriculum design, project guidance, and graduation evaluation. Resource openness involves upgrading corporate training centers, innovation hubs, and operational production lines into shared practical training bases. Institutions gain access to data interfaces, process case studies, and cutting-edge equipment, with operational costs shared on a cost-recovery basis. Talent reservation is achieved through the model of signing a contract upon enrollment and customization upon training. One year in advance, enterprises and institutions jointly formulate position competency lists and evaluation standards. Graduates commence employment immediately upon completion, with remuneration and career progression pathways pre-determined, achieving seamless alignment between corporate needs and talent development.

5.4. Third party: Certification, evaluation, and service as a trinity

Third parties integrate into the entire training lifecycle through a three-pronged model of certification, evaluation, and service. On the certification side, a star-level certification system is developed based on the industry technology map to quantitatively evaluate the degree of course connection, faculty matching, student growth, and enterprise satisfaction, and issue a nationally recognized integrated quality star label. On the evaluation side, the annual integrated education quality bluebook is published, employing big data analysis, employer interviews, and graduate tracking to benchmark against national peers and generate improvement roadmaps. On the server side, an online diagnostic platform delivers one-stop solutions including course review, teacher training, enterprise liaison, and risk alerts. This transforms certification outcomes into actionable improvement directives and evaluation conclusions into service orders, elevating third parties from external adjudicators to symbiotic partners.

6. Conclusion

The high-quality development of integrated education cannot be achieved without a systematic quality assurance and evaluation feedback mechanism. The CQAS-AFIS dual-drive model constructed in this paper provides a theoretical framework and operational path for solving the quality dilemma of integrated education through co-developed standards, co-governed processes, co-managed evaluations, data sharing, and improvement co-responsibility. In the future, it is necessary to further strengthen the application of new technologies such as artificial intelligence and blockchain in quality monitoring and early warning, explore regional differentiated implementation approaches, carry out long-term tracking research on students' career trajectories, continuously improve institutional design, and truly realize the transition of integrated education from academic continuity to capability continuity and quality continuity.

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