

Research on the Teaching Quality Evaluation System of Vocational Undergraduate Education from the Perspective of Industry–Education Integration: A Qualitative Analysis of the Intelligent Connected New Energy Vehicle Professional Group

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Abstract: Industry–education integration has become a core pathway for reforming vocational undergraduate education in China. However, the current teaching quality evaluation system remains predominantly school-centered, lacking systematic embedding of an industry-education integration perspective. This study adopts a qualitative methodology combining literature review, policy text analysis, and international comparison. Drawing upon the CIPP evaluation model, it constructs a diagnostic framework centered on "evaluation questions" with "degree of industry-education integration" serving as a meta-variable that cuts across all dimensions. The findings reveal that policy text coding identifies three structural deficiencies in China's evaluation supply: the absence of institutional guarantees for enterprise evaluation weight, the lack of specific operational guidance for process evaluation, and the missing closed-loop mechanism for industrial feedback. International comparison demonstrates that both the German dual system and the UK degree apprenticeship position enterprises as "equal evaluation subjects," offering significant lessons for China's evaluation reform. The study ultimately constructs a four-dimensional, industry-education integration-oriented evaluation framework encompassing context, input, process, and product, and uses the Intelligent Connected New Energy Vehicle Professional Group as an illustrative case to demonstrate its adaptation logic and operational mechanism. This paper provides theoretical reference and operational guidance for the reform of vocational undergraduate education evaluation in the context of China's "breaking the five-only" evaluation policy.

Keywords: Industry–education integration; Vocational undergraduate education; Teaching quality evaluation system; CIPP model; Intelligent Connected New Energy Vehicle professional group

1. Introduction

1.1 Research Background

In 2019, China's State Council issued the National Vocational Education Reform Implementation Plan (Guofa [2019] No. 4), which explicitly states that "vocational education and general education are two different types of education with equal importance" and designates "promoting industry–education integration and school–enterprise cooperation" as the fundamental model for vocational education [1]. In 2022, the General Offices of the CPC Central Committee and the State Council jointly issued the Opinions on Deepening the Reform of the Modern Vocational Education System, further positioning industry–education integration as the core lever for building a modern vocational education system [2]. Against this policy trajectory, vocational undergraduate education—as an innovative institution at the bachelor's degree level—has rapidly expanded from pilot programs to scale. By 2025, the number of vocational undergraduate institutions in China had exceeded 50, and the growth trend continues to accelerate [3]. The revised Vocational Education Law of 2022 provided the legal foundation for vocational education at the undergraduate level [4], and the Ministry of Education subsequently issued administrative measures to regulate the establishment of undergraduate-level vocational programs [5].

Nevertheless, such scale expansion gives rise to a pressing institutional question: how to ensure the teaching quality of vocational undergraduate programs? The quality evaluation system serves as the "baton" that directs educational quality assurance. Currently, most vocational undergraduate institutions continue to rely on evaluation frameworks inherited from conventional undergraduate or higher vocational colleges. The fundamental shortcoming of these frameworks lies in the fact that industry–education integration is treated merely as a "peripheral variable" rather than an "endogenous dimension" of evaluation. In other words, the evaluation system measures "teaching behaviors within the school" rather than "the effectiveness of industry–education collaborative talent cultivation." This structural misalignment renders the industry–education integration policy ineffective at the "last mile"—the quality evaluation stage.

1.2 Problem Statement

Based on the above context, this study addresses three core research questions:

First, the cognitive dilemma: What exactly should an industry–education integration-oriented teaching quality evaluation assess? Existing evaluation frameworks are largely transplanted from conventional undergraduate education, with core indicators revolving around classroom teaching quality, research output, and examination performance—none of which capture the defining characteristics of vocational undergraduate education as a "type" of education. The key dimensions that should be evaluated—enterprise participation, alignment with industrial demand, and the actual effectiveness of school–enterprise collaborative education—lack systematic expression in the current system.

Second, the subject dilemma: Why has the enterprise's evaluative role been persistently marginalized? Although policy documents repeatedly emphasize "dual-subject" (school and enterprise) education, in practice, schools remain the sole evaluation subject. Enterprise participation in evaluation lacks institutional safeguards, incentive mechanisms, and operational protocols. Consequently, enterprise evaluative opinions cannot be institutionally integrated into the quality improvement loop.

Third, the methodological dilemma: Can quantitative ranking truly diagnose teaching quality? The prevailing model of teaching quality evaluation relies on numerical scoring and comparative

ranking. While this approach satisfies accountability requirements, it struggles to reveal deeper issues within the teaching process—particularly the "soft" dimensions of industry–education integration, such as the transmission of tacit knowledge by enterprise mentors and the depth of authentic project-driven learning.

1.3 Research Significance

Theoretically, this study attempts to integrate the CIPP evaluation model with industry–education integration theory, constructing a two-dimensional analytical matrix of "CIPP × degree of industry–education integration," thereby extending the application boundaries of the CIPP model within the domain of vocational undergraduate education. Practically, the study not only proposes a qualitative diagnostic framework but also uses the Intelligent Connected New Energy Vehicle Professional Group—a representative professional cluster corresponding to a strategic emerging industry—as an illustrative case to demonstrate the framework's adaptation logic and application pathways, providing a direct reference for teaching quality reform in similar professional groups.

1.4 Research Methodology and Framework

This study employs four research methods: (1) literature review, systematically tracing the theoretical evolution and current research status of teaching quality evaluation both domestically and internationally; (2) policy text analysis, coding core policy documents on industry–education integration and vocational undergraduate education at the national level; (3) comparative research, horizontally contrasting the evaluation mechanisms of the German Duale Hochschule and the UK degree apprenticeship to extract transferable institutional insights; and (4) theoretical construction, using deductive reasoning based on the CIPP model to build an industry–education integration-oriented teaching quality evaluation framework.

The research framework proceeds as follows: literature foundation → CIPP theoretical framework construction → policy text coding analysis → international comparison insight extraction → derivation of evaluation dimensions and core questions → adaptation analysis for the Intelligent Connected New Energy Vehicle Professional Group → conclusions and recommendations.

2. Literature Review

2.1 The Evolution of Teaching Quality Evaluation Theory

The development of modern educational evaluation theory has undergone roughly four stages. The first generation is represented by Ralph W. Tyler's goal-oriented model. His 1949 publication, *Basic Principles of Curriculum and Instruction*, systematically articulated the evaluation logic of "judging educational effectiveness against pre-established objectives" [6]. While clear and pragmatic, this model presumes the rationality of the objectives themselves, neglecting the need to evaluate the objectives.

The second generation, represented by Cronbach and Scriven, emphasized the distinction between formative and summative evaluation, as well as the importance of evaluator independence. Building on this, Daniel L. Stufflebeam proposed the CIPP evaluation model in the 1960s, which divides evaluation into four dimensions: Context Evaluation, Input Evaluation, Process Evaluation, and Product Evaluation. Stufflebeam argued that the fundamental purpose of evaluation is "improvement" rather than "proof," and that evaluation should serve decision-making rather than

mere judgment [7]. Owing to its full-process coverage and decision-oriented nature, the CIPP model has been widely applied in educational program evaluation. The model has since been refined into a comprehensive guide for evaluation practice [8].

The third generation, represented by Stake's "responsive evaluation," emphasized that evaluation should respond to stakeholder concerns rather than to the evaluator's pre-set agenda. The fourth generation was systematically articulated by Egon G. Guba and Yvonna S. Lincoln in their 1989 work *Fourth Generation Evaluation*, which posits that evaluation is fundamentally a process of "negotiated construction." Evaluators should serve as "facilitators," promoting dialogue and consensus among multiple stakeholders [9]. The "stakeholder participation" philosophy of fourth-generation evaluation provides crucial theoretical support for the discussion of the enterprise's role in industry–education integration evaluation.

In the Chinese context, the CPC Central Committee and the State Council issued the Overall Plan for Deepening the Reform of Educational Evaluation in the New Era in 2020, explicitly advocating the "breaking of the Five-Only"—namely, breaking the overreliance on scores, admission rates, diplomas, papers, and titles as evaluation criteria [10]. This policy imposes institutional requirements for a fundamental paradigm shift in educational evaluation. Vocational undergraduate education, due to its positioning as a "type" of education, is particularly in need of pioneering new evaluation paradigms that transcend traditional quantitative ranking.

2.2 Current Status of Industry–Education Integration Evaluation Research

Domestic scholarship on industry–education integration quality evaluation has accumulated to a certain degree and can be categorized into three orientations:

Input-oriented research focuses on the resource supply dimension of industry–education integration, addressing indicators such as enterprise financial input, training equipment allocation, and the proportion of dual-qualification teachers [11]. The advantage of this approach lies in the objectivity and comparability of indicators; its obvious shortcoming, however, is that resource input does not equate to educational effectiveness—high input does not necessarily lead to high quality.

Process-oriented research examines the operational mechanisms of school–enterprise collaborative education, such as enterprise participation in curriculum development and the quality of practical training processes [12]. This orientation compensates for the "seeing resources but not people" limitation of input-oriented research, yet due to the difficulty of standardizing process indicators, it often remains at the level of qualitative description without systematic analytical tools.

Output-oriented research concentrates on the terminal outcomes of talent cultivation, such as job-matched employment rates, enterprise satisfaction, and vocational skill certificate acquisition rates [13]. The strength of output orientation lies in its direct association with industrial demand, but it may overlook the processual value of talent cultivation and unquantifiable growth dimensions.

The structural deficiency of existing research is evident: most studies position industry–education integration evaluation as "incremental evaluation"—adding a few industry–education integration-related indicators onto the existing school-centered teaching quality evaluation framework—without fundamentally redefining the underlying logic of evaluation. The evaluation subjects, criteria, and methods have not undergone structural transformation as a result of industry–education integration. This reflects the need for practical strategies that systematically embed industry perspectives into evaluation logic [14].

It is noteworthy that some scholars have attempted to introduce the CIPP model into the domain

of industry–education integration evaluation. Sun Jian et al. (2024) constructed a quality evaluation indicator system for industry–education integration in vocational colleges based on the CIPP model, using the Analytic Hierarchy Process (AHP) to determine indicator weights [15]. This study provides an important methodological reference for the present work, although its emphasis on quantitative weight assignment leaves room for expansion in the qualitative diagnostic dimension.

2.3 The Uniqueness of Vocational Undergraduate Education Evaluation

The defining characteristic that distinguishes vocational undergraduate education from both conventional undergraduate and higher vocational education lies in its "technological logic." Conventional undergraduate education follows "disciplinary logic," organized around the completeness of knowledge systems; higher vocational education is driven by "skill logic," with the single-skill requirements of occupational positions serving as training standards. Vocational undergraduate education carves out a third path between the two: it is not simply "undergraduate plus skills" but is oriented around "technological integration" and "problem-solving" as core competencies, requiring students to possess cross-domain technological integration capabilities and the ability to solve unstructured problems in complex work contexts [16]. This orientation is grounded in the established theoretical foundations of vocational pedagogy [17,18], which emphasize the purposeful integration of theoretical knowledge with practical competence [19]. Recent scholarship has further explored the theoretical construction and practical dimensions of vocational undergraduate education [20], while comparative European research reveals divergent approaches to conceptualizing knowledge, skills, and competence in vocational education [21].

This typological difference imposes a fundamental requirement on the evaluation system: the teaching quality evaluation of vocational undergraduate programs cannot simply transplant the "academic evaluation" framework of conventional undergraduate education, nor can it be downgraded to the "skill assessment" framework of higher vocational colleges. Instead, a new evaluation paradigm matching the "technological logic" must be constructed. Industry–education integration is the core pillar of this paradigm—the criteria for evaluating technological competence should not be unilaterally defined by the school but should emanate from the genuine demands of industrial practice.

2.4 Research Gaps and the Present Study's Entry Point

Based on the literature review, three clear research gaps can be identified: (1) Specialized research on teaching quality evaluation at the vocational undergraduate level is severely lacking, with existing studies predominantly focused on the higher vocational college level; (2) There is an absence of customized evaluation frameworks tailored to specific strategic emerging industry professional groups—the forms of industry–education integration vary substantially across industries, and evaluation systems should reflect differentiated adaptation rather than a one-size-fits-all approach; (3) The "industry perspective" has yet to be transformed from a "peripheral variable" into an "endogenous dimension" of evaluation, with existing research largely making incremental additions to established school-centered evaluation frameworks without attempting to reconstruct the underlying logic of evaluation through the lens of industry–education integration.

The entry point of this study is: abandoning the path dependency of "quantitative scoring," returning to the diagnostic essence of evaluation, constructing a qualitative diagnostic framework centered on "evaluation questions" with the "degree of industry–education integration" serving as a transversal meta-variable, and using the Intelligent Connected New Energy Vehicle Professional

Group as an illustrative case to verify its adaptability.

3. Theoretical Framework: Integrating the CIPP Model with Industry–Education Integration

3.1 Applicability Analysis of the CIPP Evaluation Model

The four evaluation dimensions of the CIPP model exhibit a high degree of logical coherence with industry–education integration-oriented teaching quality evaluation:

Context Evaluation addresses the question "What needs to be done?" In the industry–education integration context, this translates into: What is the talent demand structure of the industrial chain? Are the training objectives rooted in authentic industrial demand? Are industrial technology iteration trends systematically incorporated as a basis for training program revision? The substance of context evaluation is to determine whether the "demand side" of industry–education integration has been accurately identified and systematically addressed.

Input Evaluation addresses the question "With what resources?" In the industry–education integration context: Does the supply of teaching resources (faculty, curriculum, training facilities) reflect industry–education integration characteristics? Is the industrial practice experience of enterprise part-time teachers matched with their teaching assignments? What is the substantive proportion of school–enterprise co-developed courses in the curriculum system?

Process Evaluation addresses the question "How is it being done?" In the industry–education integration context: What is the depth and authenticity of school–enterprise collaboration in the teaching implementation process? Are authentic enterprise projects genuinely integrated into the teaching process rather than remaining at the level of "visit-style" training? Is the participation of enterprise mentors in the teaching process substantive rather than formalistic?

Product Evaluation addresses the question "Has it been accomplished?" In the industry–education integration context: Do talent cultivation outcomes meet industry value standards? Is the enterprise satisfaction feedback mechanism institutionalized? Is the workplace adaptability of graduates systematically tracked?

3.2 The Theoretical Embedding Mechanism of the Industry–Education Integration Perspective

The core theoretical innovation of this study lies in defining the "degree of industry–education integration" as a meta-variable that cuts across the four CIPP dimensions, rather than as an additional dimension appended to CIPP. This entails:

Demand Embedding (Context): Industry demand drives the setting of training objectives. What is evaluated is not "what the training objectives say" but "whether the training objectives are rooted in authentic industry demand analysis."

Resource Embedding (Input): Enterprise resources are injected into teaching conditions. What is evaluated is not "whether there are enterprise teachers" but "whether the structural participation of enterprise teachers has transformed the quality profile of the teaching process."

Action Embedding (Process): School–enterprise collaboration pervades teaching implementation. What is evaluated is not "how many school–enterprise cooperation agreements have been signed" but "whether school–enterprise collaboration has achieved meaningful integration at every critical juncture of teaching implementation."

Value Embedding (Product): Industry evaluation defines talent standards. What is evaluated is not "what is the employment rate" but "whether the value judgments of employing enterprises are institutionally fed back into the full-process improvement of talent cultivation."

3.3 The “CIPP × Industry–Education Integration” Two-Dimensional Analytical Matrix

Based on the theoretical embedding described above, the following analytical matrix is constructed (Table 1).

Table 1: Analytical Matrix of Embedding Dimensions and Evaluation Types.

Embedding Dimension	Context Evaluation	Input Evaluation	Process Evaluation	Product Evaluation
Demand Embedding	Does industry talent demand drive training objective setting?	Does industry demand drive the direction of curriculum resource development?	Do industrial technology updates drive the dynamic adjustment of teaching content?	Do industry employment standards define the success criteria for talent cultivation?
	Does the industrial resource landscape influence the design of professional group structure?	Do enterprises substantively invest in teachers, equipment, and projects?	Are enterprise resources effectively transformed and utilized in the teaching process?	Has enterprise resource input produced measurable educational effects?
Action Embedding	Is the school–enterprise cooperation mechanism institutionalized at the contextual level?	Is there a clear institutional arrangement for resource allocation in school–enterprise collaboration?	Has school–enterprise collaboration in teaching implementation achieved organic integration?	Are the outcomes of collaborative education mutually recognized by both parties?
Value Embedding	Are enterprise value expectations for talent cultivation effectively translated by policy?	Does the value orientation of teaching resources reflect industry demand orientation?	Does value transmission in the teaching process bridge industry and education?	Are evaluation value standards jointly defined by school and enterprise?

4. Policy Text Analysis: The Institutional Context of China's Industry–Education Integration Evaluation

4.1 Analytical Framework and Coding System

To achieve an in-depth understanding of the institutional context of China's industry–education integration evaluation, this study selected seven core policy documents issued between 2014 and 2025 for coding analysis (see Table 2), employing a three-level coding method based on grounded

theory—open coding, axial coding, and selective coding—with manual coding guided by the Nvivo qualitative analysis logic.

Table 2: Policy Text Analysis Sample.

No.	Document Title	Issuing Body	Year
1	Decision on Accelerating the Development of Modern Vocational Education	State Council	2014
2	National Vocational Education Reform Implementation Plan	State Council	2019
3	New Energy Vehicle Industry Development Plan (2021–2035)	General Office of the State Council	2020
4	Opinions on Promoting High-Quality Development of Modern Vocational Education	General Offices of the CPC Central Committee and the State Council	2021
5	Vocational Education Law of the People's Republic of China (Revised)	Standing Committee of the National People's Congress	2022
6	Opinions on Deepening the Reform of the Modern Vocational Education System	General Offices of the CPC Central Committee and the State Council	2022
7	Overall Plan for Deepening the Reform of Educational Evaluation in the New Era	CPC Central Committee, State Council	2020

The coding categories cover five dimensions: evaluation subject (who evaluates), evaluation object (what is evaluated), evaluation criteria (against what standard), evaluation method (how to evaluate), and result utilization (how are results used afterward).

4.2 Core Findings: "Three Strengthenings" and "Three Deficiencies" in Policy Supply

Through systematic coding analysis of the policy texts, this study identifies two fundamental characteristics of China's industry–education integration evaluation policy:

The "Three Strengthenings"—Constructive Policy Supply:

First, the strengthening of the school–enterprise co-evaluation concept. From the 2014 Decision's "establish and improve the vocational education quality evaluation system" to the 2022 Opinions' "improve the quality assurance system," policy discourse has progressively moved from "school self-evaluation" toward "multi-stakeholder participation," with the concept of school–enterprise co-evaluation repeatedly affirmed. Second, the strengthening of "dual-qualification" teacher standards. The 2019 "20 Articles on Vocational Education Reform" explicitly required that dual-qualification teachers account for over 50 percent of professional course teachers, accompanied by an enterprise practice experience recognition system [1]. Third, the strengthening of training facility standards. Multiple policy documents have set explicit requirements for per-student training equipment

standards and school–enterprise co-constructed training bases. These developments can be traced back to the State Council's 2014 Decision on Accelerating the Development of Modern Vocational Education [22], and were further reinforced by the 2021 Opinions on Promoting High-Quality Development of Modern Vocational Education [23].

The "Three Deficiencies"—Institutional Gaps in Policy:

First, the deficiency in institutional guarantees for enterprise evaluation weight. While policy documents repeatedly reference "enterprise participation in evaluation," they have never specified the proportional weight of enterprises in evaluation, nor have they established institutional channels through which enterprise evaluation opinions enter school decision-making. Enterprise evaluation remains at the level of "invited participation," lacking rigid legal and institutional safeguards. Second, the deficiency in specific operational guidance for process evaluation. Policy requirements for "teaching implementation" evaluation predominantly focus on "classroom teaching quality," with a notable absence of specific evaluation criteria and operational guidelines for the most essential aspects of industry–education integration—enterprise-based training, authentic project-driven teaching, and the school–enterprise dual-mentor system. Third, the deficiency in the closed-loop mechanism for industrial feedback. While policies emphasize outcome evaluation of "graduate employment quality," they have not established an institutionalized closed loop of "enterprise feedback → teaching improvement." There is a lack of institutional bridging mechanisms for how enterprise satisfaction survey results are translated into curriculum adjustments and teaching reforms.

4.3 Implications of Policy Text Analysis

The findings from the policy text analysis indicate that China's top-level design for industry–education integration is well-articulated at the conceptual level, yet faces a significant "last mile" bottleneck in institutional support and implementation tools. Evaluation system design should not start from scratch; rather, it should serve as a "bridge for policy implementation"—translating the core concerns embedded in policy discourse into concrete evaluation dimensions and operational judgment criteria.

5. International Comparison: Lessons from the Dual System and Degree Apprenticeship

5.1 The Evaluation Mechanism of the German Duale Hochschule

The Baden-Württemberg Cooperative State University (Duale Hochschule Baden-Württemberg, DHBW) is a benchmark for industry–education integration in German higher education. Its defining characteristic is that enterprises are not merely providers of teaching venues but "equal evaluation subjects." The assessment system comprises theoretical assessments (led by the university) and practical evaluations (led by the enterprise), each accounting for a specified proportion of credits, jointly constituting a comprehensive evaluation of the learner [24].

The institutional support for the German dual-system evaluation mechanism comes from two sources: first, the statutory role of industry chambers (IHK/HWK) in vocational qualification assessment. The chambers are responsible for setting assessment standards, appointing examiners, and organizing examinations. This "third-party evaluation" mechanism effectively safeguards the industrial representativeness and social credibility of evaluation [25]. Second, the "learning venue principle" (Lernortprinzip), under which the teaching objectives, content, and outcomes of both the university and enterprise learning venues are incorporated into a unified quality assurance

framework, preventing the fragmentation of "in-school evaluation" and "enterprise evaluation".

5.2 Quality Assurance in the UK Degree Apprenticeship

The United Kingdom formally launched Degree Apprenticeships in 2015, integrating bachelor's and master's level vocational education into the apprenticeship framework. The core of its quality assurance system is the End-Point Assessment (EPA) mechanism [26]. EPA is implemented by independent End-Point Assessment Organizations (EPAOs), which must be recognized by the Office of Qualifications and Examinations Regulation (Ofqual). EPA assessment standards are developed by "Trailblazer Groups"—groups composed of representatives from leading industry enterprises—ensuring that assessment criteria are directly aligned with industry demand [27].

The insight that the degree apprenticeship evaluation system offers for China lies in its "reverse evaluation" logic: rather than having schools first set standards and then invite enterprises to "cooperate," enterprises lead the standard-setting process, and schools organize teaching around industry standards. This "standard push-back" mechanism ensures that the evaluation system is rooted in industrial demand from the outset.

5.3 Implications for China's Vocational Undergraduate Evaluation

Three core lessons can be distilled from the international comparison:

Statutorization: The rights and responsibilities of enterprises to participate in evaluation must be explicitly guaranteed by law or regulation, rather than remaining at the level of policy advocacy. Germany's statutory chamber examination authority and the UK's Ofqual quality oversight both represent institutional practices of "statutorization."

Externalization: The establishment of third-party evaluation bodies independent of both schools and enterprises is necessary to ensure evaluation credibility. China's "1+X" certificate system, which introduces training evaluation organizations, to some extent draws on this concept, but the independence, professionalism, and coverage of third-party evaluation still have considerable room for improvement.

Reversal: Evaluation standards should flow from the industry side to the education side, not the reverse. The UK's employer-led "apprenticeship standard" development mechanism provides an actionable institutional template for "defining talent standards by industry demand."

It must be noted that the direct transplantation of international experience is not feasible. China's vocational undergraduate education operates within a unique institutional environment—a government-led vocational education system, a massive scale of enrolled students, and significant regional development disparities—all of which necessitate localized adaptation when drawing on international experience.

6. Construction of the Industry–Education Integration-Oriented Vocational Undergraduate Teaching Quality Evaluation System

6.1 Construction Principles

The evaluation system proposed in this study adheres to four core principles:

Dual-subject principle of industry–education integration: Schools and enterprises serve as co-evaluation subjects. Enterprises should carry greater weight and voice in the product evaluation dimension, particularly in judging the alignment between talent quality and industry demand. **Full-process coverage principle:** Evaluation should cover the entire chain from training objective

setting (context evaluation) to talent cultivation output (product evaluation), avoiding the fragmented evaluation approach of "emphasizing outcomes while neglecting processes." Qualitative diagnosis priority principle: The core purpose of evaluation is to diagnose problems and drive improvement, not to assign scores and rankings. Therefore, the evaluation system is organized around "evaluation questions" rather than "scoring indicators," emphasizing in-depth analysis over quantitative comparison. Professional group differentiation adaptation principle: Different professional groups exhibit significant variation in industrial characteristics, technology iteration speed, and school–enterprise cooperation forms; the evaluation system should provide a standardized analytical framework while allowing for customized evaluation emphases.

6.2 Evaluation Dimensions and Core Questions

Building on the theoretical integration of the CIPP model and industry–education integration, this study proposes the following four-dimensional evaluation diagnostic framework:

Dimension I: Context Evaluation—Are training objectives rooted in authentic industry demand?

Around this core question, evaluation should proceed from the following angles: (1) Is industrial talent demand analysis institutionally embedded in the formulation and revision process of training programs? (2) Do the competency descriptions in training objectives correspond to the genuine needs of industrial chain positions rather than representing generic statements? (3) Are industrial technology iteration trends (e.g., the "software-defined vehicle" trend in intelligent connected vehicles) systematically incorporated into the dynamic adjustment mechanism of training objectives? (4) Is the regional industrial structure reflected in the differentiated design of professional directions?

Dimension II: Input Evaluation—Does teaching resource supply reflect industry–education integration characteristics?

Core questions include: (1) Is the industrial practice experience of "dual-qualification" teachers aligned with their teaching assignments? Is the classroom teaching participation of enterprise part-time teachers substantive rather than formalistic? (2) What is the proportion and content quality of school–enterprise co-developed courses in the curriculum system—do these courses reflect enterprises' authentic technological scenarios and cutting-edge problems? (3) Training facilities—is the ratio of virtual simulation platforms to authentic enterprise equipment reasonable? Are training bases co-constructed and co-utilized by schools and enterprises? (4) Does the proportion of teaching funding from enterprises reflect the substantive degree of industry participation?

Dimension III: Process Evaluation—Does teaching implementation achieve deep school–enterprise collaboration?

The core of this dimension lies in the "authenticity of collaboration": (1) The frequency and depth of authentic enterprise projects used in teaching—are they "look-and-see" visit projects or "do-it-yourself" practical projects? (2) The participation model of enterprise mentors in the teaching process—do they participate in the full chain of teaching design, teaching process guidance, and learning outcome evaluation? (3) The management mechanism for internships/enterprise training—has a communication and evaluation mechanism involving both school and enterprise mentors been established? (4) The degree of integration of cutting-edge industrial problems into classroom teaching—the frequency and depth with which teachers introduce industrial cases in the classroom.

Dimension IV: Product Evaluation—Do talent cultivation outcomes meet industry value standards?

Core questions: (1) Is enterprise employer satisfaction institutionally fed back into the revision process of talent training programs? Has the feedback mechanism formed a closed loop of "evaluation → feedback → improvement"? (2) Systematic tracking of graduate workplace adaptability—are graduates' career development trajectories continuously tracked and used to feed back into teaching improvement? (3) Innovative outcomes of talent cultivation—do the solutions, technical patents, and skill competition achievements produced by students in addressing authentic enterprise technical problems reflect the educational effectiveness of industry–education integration? (4) Enterprises' willingness to re-engage—are enterprises willing to continue participating in school–enterprise cooperation projects and increase their investment? This serves as the best "market test" of product evaluation.

6.3 Reshaping the Roles of Evaluation Subjects

The core institutional design proposed by this study is the establishment of a "tripod" evaluation subject structure: School Quality Evaluation Center (internal quality assurance), Enterprise Evaluation Committee (industrial demand representation), and Industry Association Intermediary Evaluation (third-party credibility assurance).

The institutional vision for the Enterprise Evaluation Committee includes: (1) The committee is composed of technical directors, human resources directors, and frontline technical backbone personnel from cooperating enterprises; (2) The committee holds a "one-vote inquiry right" in the product evaluation dimension—if the committee determines that graduate quality fails to meet basic industry standards, it has the authority to require the school to initiate a quality rectification process; (3) The committee participates in the annual review of training programs, ensuring that training objectives remain dynamically aligned with industry demand.

6.4 Utilization Pathway for Evaluation Results

The vitality of an evaluation system lies in whether its results can drive improvement. This study proposes a four-step closed loop of "Diagnosis → Feedback → Improvement → Tracking":

Diagnosis: Based on the four-dimensional evaluation questions, a qualitative teaching quality diagnostic report is produced, identifying areas of strength and areas of weakness. Feedback: The diagnostic report is fed back bilaterally to both school and enterprise management levels and to the front-line teaching staff, ensuring undistorted information transmission. Improvement: In response to the weaknesses identified in the diagnosis, a school–enterprise collaborative improvement plan is formulated, specifying responsible parties, timelines, and expected objectives. Tracking: In the next evaluation cycle, focused attention is given to whether the weaknesses identified in the previous round have been effectively addressed, forming a spiral upward quality improvement mechanism.

7. Applicability Analysis: The Intelligent Connected New Energy Vehicle Professional Group

7.1 Industrial Background and Talent Characteristics of the Professional Group

Intelligent Connected New Energy Vehicles are designated as a core strategic direction in the New Energy Vehicle Industry Development Plan (2021–2035) [28]. The industry is undergoing a profound transformation from "electrification" to "intelligentization": vehicles are no longer merely a means of transportation but an integrated entity of "mobile intelligent terminal + energy storage unit + digital space." This industrial transformation imposes new demands for cross-disciplinary integration on talent—traditional automotive engineering professionals must now possess multi-disciplinary

knowledge in electronic information, artificial intelligence, and communication technologies, as well as cross-domain problem-solving capabilities. According to industry forecasts, the rapid development of intelligent connected vehicles has generated urgent demand for interdisciplinary talent [29].

The Intelligent Connected New Energy Vehicle Professional Group typically encompasses core programs such as Intelligent Connected Vehicle Technology, New Energy Vehicle Technology, and Automotive Electronics Technology. Its talent cultivation exhibits three distinctive features: (1) Technological cross-disciplinarity—the curriculum system integrates three major disciplines: vehicle engineering, information technology, and data science; (2) High-speed iteration—technological directions such as autonomous driving algorithms, V2X communication protocols, and battery management systems update extremely rapidly, requiring synchronous updating of teaching content; (3) Scenario authenticity—students' core competencies must be trained in authentic vehicle development, system integration, and road testing scenarios, which traditional classrooms cannot adequately provide.

The National Intelligent Connected Vehicle Industry–Education Integration Community was formally established in December 2023, jointly led by the National Innovation Center of Intelligent Connected Vehicles, Beihang University, and Hunan Automotive Engineering Vocational College [30]. The establishment of this community provides an initial institutional foundation and organizational vehicle for industry–education integration evaluation at the professional group level.

7.2 Problem Diagnosis in Current Teaching Evaluation Practice

Through a textual review of existing training programs, curriculum standards, and practical training plans for this professional group, combined with the findings from the policy text analysis, three major problems can be diagnosed:

First, insufficient attention to "cross-disciplinary integration" in evaluation. Existing evaluation focuses predominantly on the classroom teaching quality of individual courses, whereas the core teaching value of the Intelligent Connected New Energy Vehicle Professional Group lies precisely in cross-disciplinary curriculum integration—whether students can comprehensively apply knowledge from mechanical engineering, electronic engineering, and software engineering in vehicle development projects. Single-course evaluation cannot capture the effectiveness of such integrative learning.

Second, the prominent problem of "virtual-real evaluation disconnection." This professional group extensively utilizes virtual simulation platforms for teaching (autonomous driving simulation, battery management system simulation, etc.), yet the evaluation linkage between virtual simulation and real-vehicle training is absent—there are no evaluation tools to test whether students' performance on simulation platforms can be effectively transferred to authentic vehicle operation scenarios.

Third, the enterprise technology push-back mechanism has not been established. Technological updates in this field are extremely rapid (e.g., the rapid advancement from L2 driver assistance to L4 autonomous driving), yet school teaching content updates often lag behind industrial practice. The existing evaluation system lacks a "technology push-back" dimension—that is, whether and with what time lag enterprise technology updates are transmitted to teaching content updates.

7.3 Adaptation Logic of the Evaluation Framework

The evaluation framework constructed in this study offers specific adaptation advantages for this professional group:

In the Context Evaluation dimension, particular attention should be paid to whether the "software-defined vehicle" trend is incorporated as a basis for revising training objectives. If training programs remain primarily oriented toward "hardware manufacturing" competencies while the industry has shifted toward "software + service" competency demands, this indicates a "demand–supply mismatch" in the context evaluation stage.

In the Input Evaluation dimension, the industrial practice experience of "dual-qualification" teachers should specifically address whether it involves the latest domains of autonomous driving, smart cockpit, and V2X, rather than merely generic "enterprise work experience." The update cycle of training equipment—particularly the update frequency of intelligent driving simulation platforms and automotive-grade chip development tools—should serve as an important evaluation focus.

In the Process Evaluation dimension, what most needs evaluating for the Intelligent Connected New Energy Vehicle Professional Group is the quality of "school–enterprise joint authentic project-based teaching"—whether students have participated in authentic enterprise projects such as autonomous driving testing, V2X function development, and battery management system optimization, and whether the pedagogical transformation of these projects is effective.

In the Product Evaluation dimension, beyond generic employment rate and enterprise satisfaction indicators, this professional group should particularly attend to the proportion of graduates employed in "software-defined vehicle"-related emerging positions, as well as enterprises' willingness to re-engage in cutting-edge directions such as autonomous driving and smart cockpit.

7.4 Vision for the Evaluation Operational Mechanism

For the Intelligent Connected New Energy Vehicle Professional Group, it is recommended to leverage the organizational platform of the "National Intelligent Connected Vehicle Industry–Education Integration Community" to establish a "Community Evaluation Working Group" as a permanent evaluation body. The working group would be composed of quality management personnel from community member institutions, technical committee representatives from member enterprises, and industry association experts, bearing responsibility for annual teaching quality diagnosis. The recommended evaluation frequency is: routine data collection (per semester), annual diagnostic report (once per year), and periodic comprehensive evaluation (once every three years, synchronized with major training program revisions).

8. Conclusions and Recommendations

8.1 Main Conclusions

Through theoretical construction, policy analysis, and international comparison, this study reaches the following core conclusions:

First, the industry–education integration perspective fundamentally reshapes the underlying logic of vocational undergraduate teaching quality evaluation. The core question of evaluation shifts from "Is the school teaching good?" to "Has the school–enterprise collaborative cultivation process produced talent value recognized by the industry?" This logical shift requires the evaluation system to transition from "school-centered" to "school–enterprise co-evaluation," and from "quantitative ranking" to "qualitative diagnosis".

Second, the theoretical integration of the CIPP model with the "degree of industry–education integration" meta-variable constructs an effective four-dimensional qualitative analytical framework. This framework, encompassing 16 analytical units, covers the complete evaluation chain from

training objective setting to talent output, maintaining theoretical coherence while embodying the transversal nature of industry–education integration.

Third, policy text analysis reveals the institutional bottlenecks facing China's industry–education integration evaluation—the "three strengthenings" indicate conceptual consensus at the policy level, while the "three deficiencies" reveal the lag in supporting institutions. Evaluation system design must serve as a "bridge for policy implementation," translating conceptual consensus into operational tools.

Fourth, international comparison demonstrates that the enterprise as an "equal evaluation subject" is an institutional prerequisite that cannot be circumvented in industry–education integration evaluation. Germany's statutory chamber examination mechanism and the UK's employer-led standard-setting mechanism offer three core lessons for China's institutional design: "statutorization, externalization, and reversal".

8.2 Policy Recommendations

At the conceptual level: Shift from "management-oriented evaluation" to "diagnosis-oriented evaluation." Education administrative authorities should guide vocational undergraduate institutions to reposition the primary function of evaluation from "standards compliance verification" to "diagnostic improvement," reducing excessive reliance on ranking and scoring, and increasing in-depth diagnosis and quality dialogue in the teaching process.

At the institutional level: Establish legal safeguards and incentive mechanisms for enterprise evaluation participation. It is recommended that the next revision of the Vocational Education Law further specify the rights and responsibilities of enterprises to participate in vocational undergraduate education quality evaluation. Concurrently, enterprise performance in industry–education integration evaluation should be incorporated into the consideration scope for high-tech enterprise certification and industry–education integration enterprise certification.

At the methodological level: Develop "question-oriented qualitative evaluation guidelines." Educational research institutions and industry associations should collaboratively develop qualitative evaluation operational guidelines tailored to different professional groups, providing schools and enterprises with concrete and usable evaluation tools rather than vague principled requirements.

At the professional group level: Advance differentiated evaluation through industry–education integration communities. Professional groups aligned with different strategic emerging industries should leverage the already-established industry–education integration communities to establish joint evaluation working mechanisms, achieving coordination and mutual recognition of evaluation standards at the industry level.

8.3 Research Limitations and Future Directions

The limitations of this study are mainly reflected in three aspects: (1) As a qualitative study, the evaluation framework constructed here has not yet undergone empirical testing across multiple institutions and professional groups; its reliability and validity await verification through case studies or action research in subsequent work; (2) The industrial technology iteration speed of the Intelligent Connected New Energy Vehicle Professional Group far exceeds that of traditional industry professional groups, and the evaluation framework proposed in this study may require adjustments to evaluation dimension emphases and specific questions when adapted to other types of professional groups; (3) The policy environment is in a period of rapid change—for instance, the newly revised Vocational Education Program Catalogue of 2025 has already adjusted the programs related to

intelligent connected vehicles, and the evaluation system needs to establish institutional safeguards for dynamic updating.

Future research can advance in three directions: (1) Selecting three to five representative vocational undergraduate institutions within the Intelligent Connected New Energy Vehicle Professional Group for multi-case comparative research, to verify the applicability of the evaluation framework and refine the operational guidelines; (2) Extending the evaluation framework to professional groups corresponding to other strategic emerging industries (e.g., integrated circuits, artificial intelligence, biomedicine), to compare the differentiated configuration of evaluation dimensions under different industrial contexts; (3) Conducting empirical longitudinal research on evaluation results, to examine whether teaching quality diagnoses based on this framework genuinely promote teaching improvement and enhanced talent cultivation quality.

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