

Competition-Teaching Integration: A Collaborative Mechanism for Industry-Oriented Vocational Education Reform in Yunnan

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Abstract: This paper examines Yunnan Province's competition-teaching integration mechanism as an innovative approach to aligning vocational education with industrial upgrading. Facing acute shortages of skilled technicians in green energy, biomedicine, and cross-border logistics, Yunnan introduced a collaborative model linking government, industry, and education within a demand-driven, feedback-responsive framework. Through competitions that transform enterprise "pain points" into learning scenarios, students gain applied expertise while their outputs inform curriculum and certification reform. Drawing on official data and provincial case evidence, the study analyzes the theoretical foundations—demand-driven education, situated learning, and educational feedback—and the governance structure that operationalizes them. It further proposes optimization strategies emphasizing enterprise co-governance, digital-platform construction, and regional cooperation under the Lancang-Mekong framework. Findings show that Yunnan's mechanism has built a closed loop of "industrial demand → competition → curriculum → employment feedback", improving skill relevance, institutional collaboration, and policy efficiency. The paper concludes that the Yunnan model provides a scalable pathway for integrating vocational education and industrial innovation in developing regions, offering policy implications for China's national modernization agenda and for international cooperation in skills development.

1. Introduction

Yunnan Province is currently advancing its "3815" strategic development plan—"three years for take-off, eight years for expansion, and fifteen years for leapfrogging"^[1,2]. At this pivotal stage, five pillar industries—green energy, biomedicine, cross-border logistics, advanced manufacturing, and plateau-featured agriculture—have become the core engines driving the province's high-quality growth^[3,4]. According to the Statistical Bulletin of Yunnan Province on National Economic and Social Development (2023), the province's GDP reached RMB 3,059.582 billion in 2023, and these five industries contributed significantly to this achievement^[1].

However, the strong momentum of industrial upgrading is now constrained by a severe shortage of highly skilled technical professionals^[5,6]. The Catalogue of Urgently Needed and Scarce Talents in Yunnan's Key Industries (2025), jointly issued by the Provincial Department of Industry and Information Technology and several other agencies, identifies 229 categories of scarce positions across 1,925 enterprises, covering more than 1.43 million talent records. It reveals that key positions such as innovative drug R&D specialists in the biopharmaceutical sector and new energy technology engineers in the green energy sector suffer from serious supply gaps. This talent deficiency has become a structural bottleneck to industrial transformation^[7,8]. For example, although the biopharmaceutical industry—one of Yunnan's three major featured sectors—maintains higher R&D intensity than traditional manufacturing, its innovation commercialization efficiency remains below that of advanced regions in China. Similarly, in the fast-developing hydrogen-energy field, enterprises demand interdisciplinary professionals who can integrate photovoltaic operation, hydrogen production, and storage technologies, but vocational training systems have not kept pace^[9,10].

The underlying cause lies in the mismatch between vocational education and industrial demand^[11,12]. Field studies indicate that many technical and vocational institutions face outdated curricula, limited funds for equipment renewal, and weak links with enterprise needs^[10,13]. This situation mirrors the findings of Groot and colleagues, whose cross-country study on developing economies concluded that vocational curricula generally lag behind industrial progress. In Yunnan, even though some institutions have introduced emerging majors such as hydrogen-energy technology, the coverage of new courses remains low, and training equipment updates are slow. As a result, graduates' skills often misalign with job requirements, compelling enterprises to invest heavily in pre-employment training^[14].

To resolve this challenge, the Opinions on Deepening the Reform of the Modern Vocational Education System issued by the General Offices of the CPC Central Committee and the State Council in 2023 emphasized the need to align education and teaching reforms with industrial upgrading. Responding to this directive, Yunnan Province established a competition-teaching integration collaborative mechanism that links industrial demand, educational supply, and talent incentives in a coherent system. Within this framework, vocational skills competitions serve as a dynamic bridge between real-world industrial challenges and classroom learning. By 2024, the mechanism had involved more than 100 enterprises and 15 vocational institutions—for example, the "Finance and Taxation Industry-Education Integration Community," which connects 103 enterprises and 15 schools. Many competition topics directly stem from industrial pain points identified by companies such as Yunnan Energy Investment Group and Kunming International Land Port.

Through this mechanism, numerous competition projects have been converted into specialized courses, effectively improving the alignment between graduate competencies and industry needs. Cases such as the photovoltaic-efficiency project of Yunnan Energy and the digital customs optimization at Mohan Port demonstrate how the mechanism enhances industrial productivity while fostering educational reform. This study systematically examines the theoretical foundations, practical pathways, and implementation effectiveness of the competition-teaching integration collaborative mechanism, aiming to provide a replicable "Yunnan Model" for vocational-education reform in frontier provinces.

2. Theoretical Foundations and Implementation Framework

2.1 Conceptual Basis

The theoretical innovation of the competition-teaching integration collaborative mechanism stems from the deep synthesis of demand-driven theory, situated learning theory, and educational feedback theory, which together form the logical foundation of the mechanism's operation.

2.1.1 Demand-Driven Educational Response Theory

The demand-driven perspective stresses that educational supply must dynamically adjust to industrial and technological evolution. In Yunnan's green-energy industry, emerging sectors such as hydrogen and energy storage are expanding rapidly. According to the *Work Plan for Accelerating the Development of the Hydrogen-Energy Industry in Yunnan (2024–2025)*, the province aims to achieve total hydrogen-industry revenue of RMB 5 billion by 2025. This growth raises new expectations for the knowledge structure of technical personnel: they must master not only photovoltaic operation but also hydrogen production, storage, and safety management. Through the competition-teaching integration mechanism, these emerging industrial needs are translated directly into competition topics and curriculum content. For instance, in the 2024 Yunnan Vocational Skills Competition, new-energy-related events accounted for 45 percent of all categories, with the "Hydrogen Storage and Transport System Design" event directly reflecting the real-world requirements of the Yunnan Energy Investment Group's hydrogen-industry park project^[15].

2.1.2 Situated Learning Theory

Situated learning views competitions as authentic industrial contexts where "learning by doing" can occur. Knowledge construction happens through engaging with real problems. Vocational competitions replicate production scenarios and technical bottlenecks, enabling students to gain practical wisdom while solving genuine tasks. For example, Yunnan University of Traditional Chinese Medicine organized a "Panax Notoginseng Processing Technology Competition" that fully simulated Yunnan Baiyao's extraction-workshop environment. Competitors were required to complete cleaning, grinding, and extraction procedures within three hours and reach an enterprise-level purity standard (saponin content ≥ 85 percent). The university's *2024 Practical Teaching Quality Report* showed that participating students' internship pass rate increased by 37 percent, and their operational proficiency improved by 42 percent compared with non-participants.

2.1.3 Educational Feedback Theory

Educational feedback theory emphasizes that institutional incentives should encourage graduates to serve local industries, creating a closed loop of "training → return → upgrading." As a frontier province, Yunnan once saw 38 percent of its vocational-school graduates employed outside the province (*Yunnan Provincial Department of Education, 2022 Graduate Employment Report*). To reverse this trend, the government implemented the Implementation Opinions on Strengthening the High-Skilled Talent Team in the New Era, offering up to RMB 12,000 per year in living subsidies to graduates who remain in key local industries for at least three years. According to the *2024 High-Skilled Talent Development Bulletin* issued by the Department of Human Resources and Social Security, this policy raised the local retention rate by 21 percentage points, reaching 69 percent.

Together, these three theoretical perspectives establish the dynamic-response, practice-based, and feedback-driven logic that underpins the competition-teaching integration mechanism.

2.2 Implementation Framework

In practice, Yunnan Province has developed a four-dimensional interactive framework that links education, industry, policy, and talent development.

On the education side, a competition-outcome transformation mechanism has been institutionalized. Sixty-eight provincial demonstration majors are required to convert at least 40 percent of winning competition projects into curricular content. By 2024, 189 courses had been redeveloped from competition outcomes, covering all demonstration majors, achieving a 100 percent

conversion rate (*Special Report on Competition-Teaching Integration in Yunnan Vocational Education, 2024*). For instance, Kunming Metallurgical College incorporated its gold-award project "Smart Cleaning Robot for Photovoltaic Power Stations" into the course *New Technologies in PV Operation and Maintenance*, accounting for 35 percent of total teaching hours. Similarly, Yunnan National Defense Industry Vocational and Technical College developed 12 textbooks and 46 courseware packages from competition results, enabling three majors to achieve provincial demonstration status. A *credit-replacement mechanism* also allows gold-medal winners to replace up to two elective credits; in 2024, this policy generated 18,000 credit replacements, helping 65 percent of beneficiaries complete graduation requirements ahead of schedule (*Vocational Education Quality Report, 2024*).

At the policy level, the province established a "fund + tax + talent" three-fold support system. Financially, the Yunnan Industrial Innovation Scholarship was endowed with RMB 150 million in 2024, rewarding over 1,200 winning students and 380 instructors, with individual awards of up to RMB 50,000. In taxation, according to the *Notice on Cultivating Industry-Education Integration Enterprises* issued by the Provincial Development and Reform Commission, enterprises that provide training-equipment support to vocational institutions can offset 30 percent of the investment amount against education-surcharge obligations. Yunnan Baiyao, for example, donated freeze-drying equipment worth RMB 3.8 million, receiving a RMB 1.14 million tax deduction. On the talent side, a Competition-Talent Database was created, listing 2,300 individuals in 2024. Enterprises hired 78 percent of these candidates—42 percentage points higher than traditional recruitment efficiency (*Three-Year Action Plan for Labor and Skills Competitions, 2024–2026*).

This four-dimensional framework—linking curriculum innovation, institutional incentives, fiscal support, and enterprise participation—ensures that the competition-teaching integration mechanism operates as a sustainable, synergistic system that continuously enhances the alignment between vocational education and Yunnan's industrial upgrading.

3. Industrial Demand Transmission and Case Validation

3.1 Organizational Carrier: The Establishment of the Industry–Education Integration Promotion Center

To bridge the "last mile" between industrial demand and educational practice, Yunnan Province established a provincial-level Industry–Education Integration Promotion Center under the *Three-Year Action Plan for Labor and Skills Competitions (2024–2026)*. Jointly led by the Department of Education and the Department of Industry and Information Technology, this center serves as the key organizational carrier for collecting industrial needs, converting them into competition topics, and linking them to curriculum development.

The center adopts a "*government departments + leading enterprises + vocational institutions*" cooperative model: the Department of Industry and Information Technology identifies enterprise technical bottlenecks; the Department of Education leads the process of topic conversion; and enterprises provide real-world scenarios and expert guidance. Regular demand-matching meetings and enterprise visits ensure effective communication. A cross-sector expert advisory panel—comprising industry engineers, vocational-education scholars, and association experts—offers professional recommendations on data collection, topic selection, and curriculum alignment, expanding the coverage of enterprise participation, especially among small and medium-sized firms.

3.2 Transmission Pathway: The Three-Stage Demand Collection Model

Based on the provincial coordination framework, Yunnan has developed a standardized three-stage

transmission model known as the "*Industrial Pain Point – Expert Evaluation – Competition Conversion*" process. In the first stage, leading enterprises and small-to-medium firms from key sectors such as green energy, biomedicine, and cross-border logistics submit quarterly reports detailing their technical bottlenecks and skill requirements to the Promotion Center. Participation is encouraged through policy incentives that link reporting performance to tax deductions and eligibility for industry–education integration certification. These reports focus on authentic production challenges, including high-altitude photovoltaic maintenance, bio-extraction techniques, and intelligent cold-chain supervision.

During the second stage, an interdisciplinary committee composed of professors, engineers, and industry specialists evaluates the submissions according to *educational adaptability and technical feasibility*. The committee prioritizes those issues that possess moderate difficulty, strong simulation potential, and measurable teaching outcomes. Selected items—such as *cold-chain loss reduction along the China–Laos Railway* or *blockchain traceability optimization for Pu'er tea*—are refined into well-defined competition tasks with clear assessment indicators.

In the third stage, the screened industrial needs are seamlessly integrated into existing competition and training platforms instead of remaining isolated initiatives. Research-oriented demands are embedded in the *China International College Students' Innovation Competition*, while technical-operation demands are incorporated into the Yunnan Provincial Vocational Skills Competition; cross-disciplinary and application-driven topics enter the "*Smart Yunnan*" *Innovation & Design Competition*. This integrated approach ensures that every competition reflects real industrial demands while simultaneously nurturing technical creativity among students. According to data from the Yunnan Department of Education, the proportion of industry-aligned competition events in 2024 increased markedly compared with the previous year, signaling the deep coupling of enterprise needs with competition design and, ultimately, with vocational education curricula.

3.3 Empirical Validation: Real Cases of Demand Transmission

3.3.1 Green Energy Case: Photovoltaic Smart-Cleaning Technology Development

Yunnan Energy Investment Group, a provincial leader in green energy, collaborated with vocational colleges to tackle maintenance challenges in high-altitude photovoltaic stations. In northeastern Yunnan, strong winds and frequent sand accumulation had reduced power generation efficiency. Through the competition-teaching integration mechanism, this issue was converted into a training project emphasizing high-altitude adaptability and cost control. Students at Kunming Metallurgical College worked with enterprise engineers to design an optimized cleaning mechanism that significantly improved generation efficiency and reduced manual costs. The solution has since been piloted at several photovoltaic bases, directly demonstrating the mechanism's ability to solve real industrial problems.

3.3.2 Cross-Border Logistics Case: Optimization of Customs Clearance Efficiency

For the China–Laos Railway, Yunnan International Land Port Development and Operation Co., Ltd. collaborated with customs authorities to transform the need for digitalized customs clearance into a provincial competition topic. Mohan Port, the key railway node, handled 64,800 tons of fresh imports and exports between January and May 2024, a 3.1-fold increase year-on-year. Given the high time sensitivity of fresh products, the competition required participants to design systems compatible with actual customs workflows.

A student team from Yunnan Communications Vocational and Technical College developed an intelligent customs system integrating digital declarations and rapid inspections, cutting the clearance

time from 4.5 hours to 1.9 hours and reducing spoilage rates from 15 percent to 8.7 percent (*Mohan Port Customs Efficiency Evaluation Report, 2024*). The solution has since been implemented for cross-border agricultural trade, highlighting the tangible benefits of linking industrial challenges with educational innovation.

4. Policy Optimization and Development Outlook

Yunnan's competition-teaching integration mechanism has established an institutional foundation for linking industrial upgrading with talent development, yet its future success depends on systematic optimization. Building on the achievements of 2021–2024, the province now faces the dual challenge of deepening governance reform and scaling innovation to a national and international level.

4.1 Deepening Enterprise Co-Governance and Institutional Alignment

At present, enterprises primarily participate in topic design and resource provision, but their influence over curriculum design, skill-standard formulation, and evaluation remains limited. To realize full integration, Yunnan should institutionalize a co-governance model in which enterprises act as equal partners throughout the education cycle. *Establishing Industry Steering Committees* in vocational colleges would allow companies to regularly update course content, evaluation rubrics, and teaching equipment in line with industrial upgrades.

Additionally, the provincial Department of Education could implement a dual-advisor system, pairing enterprise engineers with academic instructors for each competition-based course. This arrangement would integrate operational experience with pedagogical rigor, ensuring that training outcomes meet both industrial and educational quality benchmarks. Over time, such collaboration would cultivate a new category of "hybrid instructors" proficient in both production technology and educational methodology.

4.2 Establishing a Digital Integration and Evaluation Platform

The sustainability of the competition-teaching mechanism depends on efficient information circulation. Currently, competition data, course outcomes, and employment feedback are scattered across multiple institutional databases, limiting the province's ability to assess long-term effectiveness. A unified digital integration platform is therefore essential.

This platform should combine three core modules: (1) a *Competition Resource Database* archiving project topics, design documents, and evaluation results; (2) a *Curriculum Innovation Tracker* mapping how competition outcomes are incorporated into teaching materials; (3) an *Employment Feedback System* collecting graduate placement data and enterprise satisfaction surveys.

By linking these modules through big-data analytics, policymakers could identify which competition themes most effectively translate into industrial innovation, thereby guiding funding priorities. Moreover, an open-access version of the platform could allow vocational colleges across China to share resources, promoting horizontal learning and nationwide dissemination of the Yunnan model.

4.3 Enhancing Fiscal and Policy Support Mechanisms

While existing funding and tax incentives have proven effective, long-term stability requires predictable fiscal arrangements. It is recommended that the *Yunnan Industrial Innovation Scholarship Fund* be transformed into a permanent revolving fund jointly managed by education, finance, and enterprise associations. Annual interest revenues and matched corporate contributions could sustain

competition operations without reliance on short-term budget allocations.

Policy frameworks should also promote multi-level coordination. Municipal governments could adopt differentiated subsidy standards based on local industrial structures—for example, higher rewards for participation in green-energy or biomedicine competitions that support strategic industries. Furthermore, integrating competition results into the provincial *Talent Evaluation System* would allow skilled participants to receive formal recognition equivalent to professional titles, reinforcing the social prestige of vocational achievement.

4.4 Expanding Regional and International Cooperation

As China's bridge to Southeast Asia, Yunnan possesses unique geographic and cultural advantages that can facilitate regional collaboration. The province should leverage its role in the *Lancang-Mekong Cooperation Framework* to organize cross-border vocational competitions with neighboring countries such as Laos, Myanmar, and Thailand. These events could promote mutual recognition of skill certifications and cultivate a transnational labor market for emerging industries like renewable energy and modern logistics.

Domestically, inter-provincial cooperation within the Southwest Economic Circle could enable resource sharing among Sichuan, Guizhou, Chongqing, and Yunnan. Establishing a joint *Southwest Alliance for Competition-Teaching Integration* would help standardize evaluation criteria, streamline talent mobility, and create a collective platform for industrial innovation in western China.

4.5 Integrating Mechanism Evaluation into the Governance System

To secure continuous improvement, Yunnan should incorporate mechanism evaluation into its broader educational-governance framework. Key performance indicators may include the proportion of competition topics derived from real industrial needs, the percentage of projects transformed into courses, graduate employment rates in strategic sectors, and enterprise satisfaction indices.

An independent *Evaluation and Accreditation Center*—operating under the provincial Education Department but staffed with external experts—could conduct periodic assessments every two years. Public disclosure of evaluation results would enhance transparency, stimulate healthy competition among institutions, and provide empirical evidence for subsequent policy adjustments.

5. Conclusion

The competition-teaching integration mechanism in Yunnan represents a pioneering effort to synchronize vocational education with industrial transformation through coordinated governance, institutional innovation, and dynamic feedback loops. By translating enterprise pain points into competition themes and embedding the resulting outcomes into curricula and certification systems, the province has built a model that is simultaneously demand-driven, practice-based, and feedback-oriented. This transformation has not only narrowed the gap between educational supply and industrial demand but also redefined vocational education as a proactive contributor to regional development rather than a passive provider of labor.

Looking ahead, the mechanism must evolve toward greater institutional maturity. Strengthening enterprise co-governance, enhancing digital governance platforms, and embedding fiscal sustainability will be central to its continued effectiveness. Regional and international cooperation—particularly within the Lancang-Mekong framework—offers Yunnan the opportunity to expand its influence beyond provincial borders, positioning the model as both a domestic benchmark and a global reference for skills governance. If such reforms are pursued, the system can generate a virtuous cycle in which industrial upgrading stimulates educational innovation, while vocational education, in

turn, accelerates economic modernization and social progress.

Ultimately, Yunnan's experience provides a replicable framework for frontier regions grappling with the challenge of aligning education and industry under conditions of rapid structural change. It demonstrates that vocational education, when embedded in collaborative governance and informed by real-world industrial demand, can function as a strategic engine of innovation, competitiveness, and inclusive growth. This reorientation not only advances China's modernization agenda but also offers valuable insights for other developing economies seeking sustainable pathways to human-capital development.

Conflicts of Interest

There are no conflicts to declare.

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