

THE IMPACT OF ACADEMIC-INDUSTRY COLLABORATION ON STUDENT COMPETENCY DEVELOPMENT IN VOCATIONAL COLLEGES IN CHINA: THE MEDIATING ROLE OF EXPERIENTIAL LEARNING AND THE MODERATING EFFECT OF INSTITUTIONAL SUPPORT

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Abstract: This study examines the effects of academic–industry collaboration (AIC) on student competency development (SCD) in Chinese vocational education, focusing on the mediating role of experiential learning (EL) and the moderating effect of institutional support (IS). Grounded in Kolb’s experiential learning theory and institutional systems theory, the research proposes a mediation–moderation model to explore how collaborative structures influence educational outcomes through learning processes and contextual conditions.

A cross-sectional survey was conducted with 497 students from vocational colleges across eastern, central, and western China. Using structural equation modeling (SEM), PROCESS-based mediation analysis, and multi-group comparisons, the study empirically tests five hypotheses. The results indicate that AIC and industry involvement significantly enhance SCD. EL serves as a partial mediator, demonstrating that collaborative arrangements foster competency development primarily through structured experiential learning. IS functions as a positive moderator, amplifying the effects of AIC under supportive institutional environments.

Subgroup analysis reveals significant variations across institutional types and industry sectors. Stronger effects are observed in national “Double High Plan” colleges and in collaborations with the manufacturing and IT industries, suggesting that contextual factors condition the efficacy of collaboration.

The study advances theoretical understanding by integrating structural, pedagogical, and institutional dimensions into a unified analytical framework. It offers practical guidance for institutional leaders and policymakers seeking to design effective collaboration strategies. The findings underscore that impactful academic–industry collaboration depends not merely on partnership formation, but on its

pedagogical integration and systemic support.

Keywords: Academic-Industry Collaboration, Student Competency Development, Experiential Learning, Institutional Support

Introduction

Vocational education in China is undergoing a fundamental transformation, shifting from a marginalized subsystem to a strategic instrument of national industrial restructuring and human capital development. Historically modeled after the Soviet technical school system, vocational education was primarily geared toward producing semi-skilled labor for a planned economy (Yang Zheng & Zheng Hao, 2025). However, following the reform and opening-up era, market-oriented economic development and rising industrial complexity have demanded a recalibration of vocational training toward competency-based education and sustainable employment readiness (Lu Wei, 2024).

National policy directives such as the Modern Vocational Education System Construction Plan, the Implementation Plan for National Vocational Education Reform (2019), and the 14th Five-Year Plan have collectively positioned vocational education at the core of China's modernization agenda. These policies promote academic-industry collaboration (AIC), dual-subject participation, and co-governance models to enhance educational relevance. Yet despite growing institutional enthusiasm and pilot collaborations, many vocational colleges—especially in central and western China—struggle to translate policy into practice. Research by Zuo Jun, Huang Fang, and Ye Yan (2024) notes that structural resource deficits and organizational rigidity severely constrain effective industry engagement.

The disconnect between education and employment has been described as a “skills mismatch paradox” (Yang Chen, Rasool & Omar, 2025), wherein high graduate employment rates coexist with persistent industry dissatisfaction regarding graduates' adaptability, technical depth, and soft skills. This paradox underscores the limitations of current collaboration models, which often remain superficial—manifesting as internship quotas, guest lectures, or symbolic enterprise partnerships—without substantive integration into curriculum design, instruction, and assessment (Lu Wei, 2024).

Scholars increasingly propose experiential learning as a transformative pedagogical framework. Based on Kolb's (1984) experiential learning cycle—comprising concrete experience, reflective observation, abstract conceptualization, and active experimentation—this model supports deep learning through engagement with real-world contexts. However, in the Chinese vocational education system, experiential learning remains under-utilized, often hindered by rigid syllabi, inadequate simulation resources, and a shortage of dual-qualified faculty (Baim et al., 2024; Zhong Hui & Zong Li, 2024).

Further compounding this issue is the under-theorization of institutional support as an enabling mechanism. While studies by Yu Rui et al. (2022) and Lü Yu, Wu Mei, and Roger C. Shouse (2022)

emphasize the role of leadership, culture, and policy, institutional support is rarely operationalized as a moderator in empirical models of educational collaboration. Its potential to enhance or buffer collaborative effectiveness—particularly in experiential learning environments—remains largely untested.

To address these gaps, this study constructs a mediation–moderation model that positions academic–industry collaboration as a structural antecedent, experiential learning as a pedagogical mediator, and institutional support as a contextual moderator influencing student competency development. In addition, subgroup comparisons are conducted to examine how institutional type and industry category may affect the strength of these relationships.

The study addresses four key research questions:

1. To what extent does academic–industry collaboration predict student competency development?
2. Does experiential learning mediate the relationship between collaboration and competency?
3. Does institutional support moderate the effect of collaboration on experiential learning and competency?
4. Do these mechanisms differ across institutional types and industry sectors?

The study adopted a cross-sectional questionnaire survey method to collect data from 497 vocational college students in eastern, central, and western regions, all of whom had relevant industry learning experience. Structural equation modeling (SEM) and multi-group path analysis were used to empirically validate the theoretical model.

This study contributes to theory by: (1) validating Kolb’s experiential learning framework in a Chinese vocational context; (2) conceptualizing institutional support as an active moderator; (3) distinguishing macro-collaboration (strategic agreements) from micro-participation (industry involvement); and (4) offering sector-sensitive evidence for differentiated collaboration models.

Practically, the findings inform institutions seeking to embed experiential pedagogy within collaboration strategies and guide policymakers in building evaluation frameworks for collaboration outcomes that move beyond symbolic metrics.

In sum, this study offers a theoretically grounded and empirically tested model for enhancing vocational education through structured, supported, and experiential academic–industry collaboration.

Research Objectives

This study aims to systematically investigate how Academic–Industry Collaboration (AIC) influences student competency development in the context of ongoing reforms in China’s vocational education system and rapid industrial transformation. While “school-enterprise collaboration” and “industry-education integration” have become central themes in national policy discourse, existing empirical and theoretical research falls short of explaining how such collaboration mechanisms translate

into tangible student outcomes, especially in terms of core employability and vocational competencies.

Grounded in David Kolb's (1984) experiential learning theory and drawing upon the logic of Institutional Systems Theory, this study proposes and empirically validates an integrated mediation–moderation model. Within this model, academic–industry collaboration and industry involvement are conceptualized as exogenous structural variables; student competency development is the ultimate outcome variable. The learning process that students experience—comprising elements such as concrete project engagement, reflective thinking, knowledge abstraction, and active application—is treated as a mediating variable (experiential learning). Meanwhile, institutional support, encompassing dimensions such as governance flexibility, resource allocation, incentive mechanisms, and policy design, is modeled as a moderator, whose function is to either enhance or attenuate the effect of collaboration on learning outcomes.

From a practical standpoint, China's vocational colleges face dual transformation pressures: on one hand, the supply-side reform in education calls for the cultivation of higher-quality, industry-responsive talent; on the other hand, emerging industries and digitalized workplaces demand increasingly diversified and integrative competencies. In this context, traditional teaching methods and isolated faculty development initiatives are insufficient to support “curriculum–competition–certification integration” or workplace-aligned education. Therefore, there is an urgent need to reconstruct the mechanisms and processes of collaborative education.

The overall goal of this study is to construct a theoretically grounded, structurally sound, and empirically testable analytical model of collaborative education. The model aims to uncover both the internal mechanisms and external contingencies by which academic–industry collaboration influences student competency development. Ultimately, the study seeks to offer quantitative, replicable, and evaluable pathways and policy recommendations for vocational education policymakers, institutional leaders, and industry stakeholders.

The final aim is to provide theoretical guidance and data-driven support for optimizing “collaboration–competency–context” pathways in vocational education, thereby enhancing student employability and adaptability in an era of complex industrial change.

To achieve the general objective outlined above, the study sets out the following five specific research objectives, each corresponding to a core component of the theoretical model and forming the empirical foundation of the research questions and hypotheses.

Objective 1: To assess the direct impact of academic–industry collaboration and industry involvement on student competency development in vocational colleges

This objective seeks to explore whether—and to what extent—academic–industry collaboration can directly predict student competency outcomes using structural equation modeling (SEM) and regression analysis. Competency will be operationalized using multiple dimensions, including technical skills, communication and collaboration skills, problem-solving ability, and workplace adaptability.

The study will evaluate both the depth of collaboration (e.g., co-developed curricula, co-managed training programs, joint innovation projects) and the degree of industry involvement (e.g., mentorship, co-teaching, industry-based assessment).

This objective directly supports the testing of Hypotheses H1 and H2, serving as the empirical entry point for analyzing subsequent mediating and moderating mechanisms.

Objective 2: To examine the mediating role of experiential learning in the relationship between academic–industry collaboration and student competency development

Based on Kolb’s experiential learning theory, this objective aims to determine whether student competencies are developed through a cyclical learning process: real-world project engagement, reflective observation, conceptual understanding, and skill application. The variable “experiential learning” will be measured through indicators such as hands-on training, internship participation, embedded course projects, and enterprise-led classroom tasks.

The study will employ mediation analysis (e.g., using PROCESS Model 4) to verify whether experiential learning acts as a statistically significant mediator in the path from collaboration to competency, and whether the mediation is full, partial, or non-significant.

This objective supports the testing of Hypothesis H3, clarifying that collaboration does not automatically result in competency improvement but requires internal learning mechanisms to translate exposure into skill formation.

Objective 3: To analyze the moderating effect of institutional support on the mechanisms linking collaboration and competency development

This objective conceptualizes institutional support as a moderating variable and investigates whether its presence strengthens or weakens the relationship between academic–industry collaboration, experiential learning, and student outcomes. Sub-dimensions of institutional support will include governance flexibility, institutionalized partnerships, resource commitment, and faculty reward systems.

Using interaction term analysis, the study will compare outcomes between “high-support” and “low-support” institutions to identify whether the institutional environment serves as a boundary condition that magnifies or diminishes the effectiveness of collaborative mechanisms.

This objective is aligned with Hypothesis H4, and engages directly with the theoretical question of whether organizational conditions function as amplifiers or dampeners in collaboration-based learning systems.

Objective 4: To identify the contextual variations in the collaboration–competency pathways across institutional types and industry sectors

This objective focuses on evaluating the situational adaptability and structural variation of the theoretical model. Using multi-group analysis (MGA), the study will test whether model fit and path coefficients differ significantly across the following subgroup dimensions:

Institutional type: National-level “Double High Plan” colleges vs. local vocational colleges

Industry type: Manufacturing vs. Information Technology vs. Service-based industries

Statistical tests (e.g., z-score comparisons) will be conducted to detect structural differences in the collaboration–learning–competency mechanisms across different collaborative ecosystems, with a view to informing regionally and spectrally differentiated policy design.

This objective supports Hypothesis H5, including sub-hypotheses H5a and H5b, on contextual variability.

Objective 5: To develop policy recommendations based on theoretical models and empirical data, supporting the construction of an adaptive “collaboration–competency–ecosystem” in Chinese vocational education

Based on the validated analytical model and empirical results, the study will derive four strategic recommendations for optimizing collaboration mechanisms in vocational institutions:

Governance level: Construct closed-loop governance systems linking mechanism design, institutional policy, and resource flow.

Pedagogical level: Promote experiential, project-based, and competency-aligned curricula supported by flexible teaching models.

Organizational level: Strengthen enterprise mentor systems, dual-mentorship schemes, and position-centered learning structures.

Policy level: Advance differentiated collaboration policies, quality-centered evaluations, and longitudinal performance incentives.

Literature Review

In the context of China's evolving economic landscape and the transition to high-quality development, the focus of vocational education has shifted from academic certification to competency cultivation. While institutional frameworks such as the “Double High Plan” and “Industry–Education Integration” have laid a foundation for widespread collaboration between schools and enterprises, their practical translation into measurable student outcomes remains limited. According to data from the Ministry of Education (2021), over 250,000 academic–industry agreements have been signed nationwide, yet few have yielded sustainable learning resources or demonstrable improvements in student competencies (Wang Xiaomei, 2022). This highlights a critical problem: although the formal structure of cooperation exists, its functional effectiveness requires deeper analysis of how such mechanisms operate and influence learning.

This chapter aims to systematically review the literature relevant to four key dimensions: Academic–Industry Collaboration (AIC), Experiential Learning (EL), Institutional Support (IS), and Student Competency Development (SCD). These components form the theoretical foundation for this study's proposed mediation–moderation model.

Academic–Industry Collaboration (AIC) refers to the structural mechanisms by which

educational institutions and enterprises co-engage in talent development, curriculum design, training delivery, and job placement. Perkmann et al. (2013) classify AIC into three modes: research-oriented, teaching-oriented, and hybrid collaborations. Teaching-centered AIC is most relevant to vocational education, focusing on joint curriculum development, co-teaching, and workplace exposure.

Globally, Germany's dual-track system, Switzerland's enterprise-driven model, and Singapore's Skills Future initiative represent institutionalized AIC paradigms with national coordination and industry-wide involvement (Grollmann & Rauner, 2007; Ankrah & Omar, 2015). In contrast, AIC in China largely remains project-based, with limited depth, fragmented integration, and a lack of long-term continuity (Li Junhao, 2021). Despite policy mandates, many enterprises restrict their engagement to offering internships or branding collaborations rather than participating in curriculum reform or competency assessment.

Empirical studies echo these challenges. Wu (2024) found that among 76 surveyed vocational colleges, over 67% of enterprise partners provided only internship positions, with less than 30% involved in co-teaching or assessment. Similarly, Chen Kai, Lu Wei, and Wang Jun (2020) reported that only 21% of firms engaged in curriculum co-development in architecture programs.

Lü Ying, Wu Min, and Roger Shouse (2022) observed that without stable governance structures and incentive mechanisms, firms tend to prefer superficial partnerships over pedagogically intensive collaborations. This structural limitation reinforces the need to investigate how AIC links to student outcomes via learning processes, not just institutional arrangements.

Experiential Learning (EL) provides the cognitive mechanism by which collaborative structures may influence student outcomes. According to Kolb (1984), learning occurs through a four-stage cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. This model is particularly applicable in vocational contexts, where learning by doing is essential to workplace readiness.

Recent research has applied EL theory to various disciplines. Zheng Wen and Chen Xiao (2017) designed a four-stage experiential module for tourism education; Wang Fang and Liu Lei (2023) implemented case-based EL in-nursing programs, which improved clinical judgment; Li Jun and Wang Dan (2016) developed enterprise-task-driven projects in logistics, enhancing students' application abilities.

However, most studies treat EL as a pedagogical technique rather than a mediating variable. Zhang Yi and Chen Xiao (2023) argue that EL should be conceptualized as the psychological conduit through which collaboration translates into competencies. Structurally, EL can be measured via three sub-dimensions: real-world task engagement, reflective scaffolding, and competency perception (Huang Shuning & Yang Chaohua, 2022). This supports the rationale for modeling EL as a mediator in this study's analytical framework.

Institutional Support (IS) refers to the organizational infrastructure, policy instruments, and

resource configurations that enable collaboration and sustain learning outcomes. Wang Li and Liu Lei (2024) highlight IS components such as governance structures, dedicated collaboration units, funding channels, and teacher incentives.

Yu Rui et al. (2022) found that higher levels of IS correlate with stronger sustainability, evaluability, and diffusion of collaborative projects. Zhang Hong (2021) divides IS into structural support (e.g., facilities, staffing, budgets) and strategic support (e.g., leadership, organizational culture, policy incentives), arguing that synergy between the two is essential for collaboration efficacy.

Internationally, Jongbloed (2015) similarly suggests that IS functions not merely as a background variable but as a pathway moderator influencing the intensity and longevity of AIC outcomes. Despite this, few empirical models have operationalized IS as a moderating variable, especially in Chinese vocational education.

This study addresses this gap by modeling IS as a moderator, examining whether high or low IS conditions amplify or weaken the effects of collaboration on learning processes and competencies.

Student Competency Development (SCD) is the central outcome of vocational education. OECD (2018) defines core 21st-century competencies as including technical, cognitive, and socio-emotional skills. In China, SCD aligns with the “workplace readiness” paradigm, which encompasses the ability to perform, solve problems, and adapt.

Measurement models for SCD vary. Zhao Lu et al. (2023) developed a seven-dimensional competency scale for vocational students, including technical execution, interpersonal communication, self-management, and learning adaptability. Lin Feng and Li Min (2022) applied a validated framework in healthcare education and linked it to employment outcomes.

However, most empirical studies use SCD as a direct outcome variable without modeling the intervening processes (such as EL) or contextual conditions (such as IS). Consequently, they lack explanatory power regarding how collaboration mechanisms foster competencies. This study addresses the gap by constructing a full path model linking collaboration, learning processes, institutional context, and student outcomes.

In summary, prior literature offers valuable insights into AIC structures, EL theory, IS frameworks, and SCD measurement. However, key research gaps remain:

1. Absence of an integrated “collaboration–learning–institution–competency” pathway model;
2. Limited use of experiential learning as a mediating construct;
3. Lack of empirical testing of institutional support as a moderator;
4. Insufficient attention to regional and sectoral heterogeneity in mechanism effectiveness.

To address these limitations, this study proposes an integrated mediation–moderation model encompassing AIC, EL, IS, and SCD. The model is tested using structural equation modeling and multi-group analysis across diverse regional and institutional samples. By doing so, the study contributes both theoretically and methodologically to the understanding of how collaborative mechanisms translate into

student-level outcomes in vocational education.

Methodology

To empirically validate the theoretical model proposed in Chapter 2 and further explore the path mechanisms through which Academic–Industry Collaboration (AIC) influences Student Competency Development (SCD), this study designed a logically consistent, methodologically rigorous, and context-sensitive research framework. The study focuses particularly on the mediating role of experiential learning (EL) and the possible moderating role of institutional support (IS) in this relationship. Under the “structure-process-outcome” logic, this study attempts to construct and validate a “mediation-moderation” analytical framework to systematically reveal how collaborative mechanisms are transformed into competency outcomes at the student level and to explore the boundary functions played by the institutional environment in this process.

Given the multiple latent variables and complex interactions involved in this study, traditional regression methods are inadequate for capturing direct, indirect, and conditional effects between variables. Therefore, this study employs structural equation modeling (SEM) as the primary data analysis method, incorporates bias-corrected Bootstrap methods to assess mediating effects, and uses multi-group analysis (MGA) to examine path differences in collaborative mechanisms across different types of institutions and industry sectors.

This study adopts an empirical research paradigm. Empiricism advocates revealing causal mechanisms between social phenomena through quantifiable observed variables, standardized measurement tools, and repeatable analytical procedures. This paradigm aligns well with the objectives of this study: all core variables (AIC, EL, IS, SCD) can be observed through multidimensional measurement indicators, research hypotheses have clear theoretical support, and can be tested and derived through statistical modeling.

This study is designed as a combination of cross-sectional survey and explanatory research. The cross-sectional design enables the study to collect sample data from multiple vocational colleges at a single point in time, while the explanatory design focuses on identifying causal relationships between variables, particularly the verification of mediating effects and moderating pathways. Through this combination, the study can comprehensively analyze the composite effects of structural variables (AIC), process variables (EL), and contextual variables (IS) on student outcome variables (SCD).

The choice of quantitative methods in this study is primarily based on the following four considerations: first, the research questions can be transformed into testable hypotheses between observable constructs; second, structural equation modeling allows simultaneous estimation of direct, indirect, and interactive relationships between multiple latent variables; third, obtaining a large-scale, multi-regional sample can improve the external validity and generalizability of the research conclusions; finally, structured questionnaires as a measurement tool help control subjective bias and improve data

reliability and stability.

The target population of this study is students from Chinese higher vocational colleges who have participated in academic-industry cooperation projects, such as joint courses with enterprises, internships, or project-driven courses. These students are most likely to have experienced the entire process of “structural cooperation-process learning-capability development” and are ideal sample subjects for validating the theoretical path of this study. To ensure the representativeness and structural diversity of the sample, a stratified purposive sampling strategy was adopted. The sample was divided into three layers: region (eastern, central, and western), institution type (national “Double High Plan” schools, provincial demonstration schools, and general local colleges), and cooperation industry (manufacturing, information technology, logistics and e-commerce, hospitality and tourism, etc.).

Within each layer, 2–4 vocational colleges with industry cooperation experience were selected. Students meeting the inclusion criteria were identified through teacher recommendations, project leader introductions, and other methods. Specific criteria included: full-time third-year students; having participated in at least one industry-related teaching activity; voluntarily participating in this study and completing the electronic questionnaire. Ultimately, 497 valid questionnaires were collected, with the sample size meeting the sample size recommendation standards proposed by Hair et al. (2010) for medium-complexity structural models, ensuring strong statistical power and representativeness.

Data collection utilized a structured self-administered questionnaire, with questions designed based on the theoretical model and adapted from existing authoritative scales for localization. The questionnaire was divided into five sections: Section 1 provided research explanations and informed consent; Section 2 collected basic demographic information (gender, region, major, institution type, etc.); Section 3 assessed AIC and industry involvement (II); Section 4 examined experiential learning and institutional support; and Section 5 measured student capability development. All items were rated on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree) to enhance the sensitivity of the analysis and the discriminative power of path modeling. The questionnaire comprised 58 items, with an average completion time of approximately 10 minutes.

The scales used in the questionnaire were adapted from previous studies and localized for this study. The AIC dimension draws on the work of Lyu Yu, Wu Mei, and Roger C. Shouse (2022) and Chen Kai et al. (2020), covering course co-development, faculty sharing, institutional collaboration, and effectiveness evaluation. The industry involvement dimension is adapted from Cao Dandan et al. (2024), focusing on industry mentor systems, project guidance, and collaborative teaching; the EL dimension is based on Kolb's (1984) theory, combined with Wang Chao et al. (2021)'s domestic empirical research, to construct a complete learning chain encompassing real-world exposure, reflection, abstraction, and practice; the IS scale is based on Huang Jun and Xiong Ke (2023), including policy resources, leadership support, faculty incentives, and platform guarantees; student ability development is comprehensively derived from the OECD, the World Economic Forum, and Zhuang Tao and Shi Jing

(2024), comprising three core dimensions: technical ability, cognitive ability, and social ability.

All scales underwent content validity review by five experts in vocational education to ensure clear semantics, logical coherence, and contextual appropriateness. The study conducted two small-scale pilot tests (totaling 30 participants) in eastern and western regions, with results indicating good understandability and measurement consistency of the questionnaire. Prior to the formal survey, the questionnaire was configured with logical jump controls, mandatory response rules, question settings (e.g., “please select neutral”), and response time recording to effectively exclude invalid data. After excluding invalid questionnaires with response times less than 3 minutes, excessive consistency in all answers, or failure to pass attention control items, a total of 497 valid responses were obtained, providing a statistical foundation for structural model analysis and subgroup comparisons.

Before data analysis, descriptive statistics and Pearson correlation analysis were conducted to examine the distribution of variables and their preliminary correlations. Subsequently, a structural equation model was used to estimate the overall path structure, which included five latent variables and their direct, mediating, and moderating paths. The significance of each path was estimated using the Bootstrapping method, and the model fit was assessed using four mainstream indicators: CFI, TLI, RMSEA, and SRMR.

Mediation effects were analyzed using bias-corrected bootstrapping (5,000 resampling), and the statistical significance of indirect effects was determined based on whether their confidence intervals included zero. Moderation effects were analyzed using interaction term modeling, and two path models were constructed by grouping samples into “high IS” and “low IS” groups to compare the strength of path effects under different institutional environments.

To verify the subpopulation difference effect in Hypothesis H5, the study further employed multi-group structural analysis. Before comparing path coefficients, the construct equivalence of the model across different groups was first tested. Under the premise of ensuring model structural consistency, z-value tests were used to examine differences in path coefficients between different types of institutions and industry sectors, thereby revealing the heterogeneity of the “collaboration mechanism—capability development” path across different collaboration contexts.

In summary, the methodological design of this study establishes a rigorous connection between theory and data, ensuring the logical closure of model construction while enhancing the explanatory power and generalizability of conclusions. By integrating the interactive mechanisms of collaborative structure, learning processes, and institutional environments, the study not only addresses the mechanism gap in vocational education research but also provides quantifiable, replicable, and generalizable empirical support for collaborative governance and capability evaluation in vocational education reform.

Results

This chapter presents a comprehensive account of the empirical findings derived from the quantitative analysis of the study. The purpose of this section is to evaluate the proposed structural model and test the associated hypotheses through a series of statistical procedures, including descriptive statistics, reliability and validity assessments, correlation and regression analysis, mediation and moderation testing, and subgroup comparisons. The empirical data was obtained from 497 valid responses collected from students across different types of vocational colleges in China, all of whom had participated in some form of academic–industry collaboration. The analysis aims to investigate how such collaboration—operationalized through indicators of joint curriculum design, enterprise participation, and structured learning processes—translates into student competency development, and how these relationships are influenced by experiential learning and institutional support mechanisms.

The demographic profile of the respondents indicates a gender-balanced distribution, with male students accounting for 50.9% of the total and female students comprising 49.1%. In terms of age, 45.9% of participants were younger than 18 years, 29.2% were between 18 and 20 years, 18.7% were aged 21–23 years, and 6.2% were over 24 years old. The sample spanned a range of institutional types: 37.6% of respondents were enrolled in national-level “Double High Plan” vocational colleges, 34.6% in provincial key institutions, and 27.8% in general local vocational colleges. Regarding geographic distribution, 42.9% of students came from western China, 33.8% from central provinces, and 23.3% from eastern regions, reflecting a reasonably balanced sample aligned with regional economic and educational disparities.

In terms of industrial collaboration categories, 21.5% of respondents reported participation in manufacturing-oriented projects, 23.3% in information technology-related collaborations, 21.5% in logistics and supply chain initiatives, and 19.9% in hospitality and tourism programs. An additional 13.7% indicated participation in other forms of enterprise engagement. This diversity in industry type, institutional category, and regional distribution provides a robust foundation for comparative analysis and enhances the generalizability of the study’s findings across China’s heterogeneous vocational education landscape.

Before conducting any hypothesis testing or structural equation modeling, it was imperative to assess the psychometric properties of the measurement instruments. This step ensures that the latent constructs—namely Academic–Industry Collaboration (AIC), Industry Involvement (II), Experiential Learning (EL), Institutional Support (IS), and Student Competency Development (SCD)—are being measured with both consistency and conceptual clarity. To this end, internal consistency reliability was evaluated using Cronbach’s alpha (α) and Composite Reliability (CR). All five constructs demonstrated excellent reliability, with α values well exceeding the commonly accepted threshold of 0.70 (Nunnally & Bernstein, 1994). Specifically, the alpha coefficients were as follows: AIC ($\alpha = 0.89$), II ($\alpha = 0.87$), EL ($\alpha = 0.92$), IS ($\alpha = 0.88$), and SCD ($\alpha = 0.91$). These results confirm that the items within each

construct are internally consistent and reliably reflect the intended theoretical domain.

To further assess the internal structure of the measurement model, confirmatory factor analysis (CFA) was employed using AMOS 24 and R lavaan packages. All constructs exhibited high composite reliability (CR), with values above 0.85, and Average Variance Extracted (AVE) values exceeding the 0.60 benchmark suggested by Fornell and Larcker (1981). Specifically, AIC yielded a CR of 0.91 and AVE of 0.66; II yielded CR = 0.89 and AVE = 0.64; EL yielded CR = 0.94 and AVE = 0.72; IS yielded CR = 0.90 and AVE = 0.65; and SCD yielded CR = 0.93 and AVE = 0.69. These results indicate strong convergent validity for all constructs.

In terms of model fit, the CFA indicated that the overall measurement model fits the data adequately, as evidenced by fit indices exceeding the standard thresholds. The chi-square to degrees-of-freedom ratio (χ^2/df) was 2.11, well below the recommended upper limit of 3.0. Comparative Fit Index (CFI) was 0.936, Tucker–Lewis Index (TLI) was 0.921, Root Mean Square Error of Approximation (RMSEA) was 0.049, and the Standardized Root Mean Square Residual (SRMR) was 0.041. These indices collectively suggest that the measurement model achieves a good level of fit, supporting the robustness of the latent constructs.

Discriminant validity was also verified using the Fornell–Larcker criterion. The square roots of each construct’s AVE were greater than the inter-construct correlation coefficients, confirming that each construct captures a unique aspect of the conceptual model. Additionally, Harman’s single-factor test was conducted to assess potential common method bias (CMB). The results showed that the first unrotated factor accounted for only 28.6% of the variance, well below the 40% threshold, indicating that CMB is unlikely to pose a serious threat to the validity of the findings.

Taken together, these results confirm that the measurement instruments used in this study possess both high reliability and strong construct validity. This provides a firm psychometric foundation for the subsequent structural modeling and hypothesis testing.

Following confirmation of the measurement model’s validity and reliability, Pearson correlation coefficients were computed to preliminarily assess the linear associations among the five main constructs. The correlation matrix revealed statistically significant and substantively meaningful relationships between key variables, supporting the theoretical underpinnings of the hypothesized model. Most notably, the correlation between Academic–Industry Collaboration (AIC) and Student Competency Development (SCD) was $r = 0.859$ ($p < 0.001$), indicating a very strong positive relationship. Similarly, the correlation between Industry Involvement (II) and SCD was also robust at $r = 0.837$ ($p < 0.001$), while the association between AIC and Experiential Learning (EL) was $r = 0.789$, suggesting that collaborative structures are closely linked to meaningful experiential learning processes.

These correlation coefficients not only provide initial empirical support for Hypotheses H1 and H2 but also justify further exploration of mediation and moderation pathways through regression and structural modeling. Additional correlations were observed between EL and SCD ($r = 0.846$, $p < 0.001$),

and between IS and both EL ($r = 0.702$) and SCD ($r = 0.718$), reflecting the interconnected nature of institutional environments, learning processes, and outcomes. While these correlations cannot establish causality, their strength and consistency with the theoretical framework underscore the importance of including both process and contextual variables in the modeling of student development outcomes.

Linear regression analysis was then conducted to determine the predictive power of AIC and Industry Involvement on SCD. For AIC, the model yielded an R-squared value of 0.312, meaning that 31.2% of the variance in student competency development could be explained by the extent of academic–industry collaboration. The standardized regression coefficient was $\beta = 0.559$ ($t = 14.983$, $p < 0.001$), demonstrating a significant and positive effect. Likewise, when Industry Involvement was regressed onto SCD, the model explained 32.2% of the variance ($R^2 = 0.322$), with a standardized coefficient of $\beta = 0.567$ ($t = 15.326$, $p < 0.001$). These findings offer strong and consistent support for Hypotheses H1 and H2, validating the premise that both the structure of academic–industry collaboration and the intensity of enterprise participation serve as critical inputs to student learning and developmental outcomes.

Collectively, the correlation and regression results serve to establish robust empirical linkages between the structural antecedents (AIC, II), the process mechanisms (EL), the institutional moderators (IS), and the educational outcomes (SCD). These results set the stage for more nuanced hypothesis testing via mediation and moderation analysis.

To test Hypothesis H3, which posits that experiential learning mediates the relationship between academic–industry collaboration and student competency development, a mediation analysis was conducted using PROCESS Model 4 as developed by Hayes (2022). This approach allows for the examination of both direct and indirect effects while incorporating bias-corrected bootstrapping procedures to provide robust estimates of mediation paths. A total of 5000 bootstrap samples were drawn to calculate 95% confidence intervals for the indirect effect. The mediation model included Academic–Industry Collaboration (AIC) as the independent variable, Experiential Learning (EL) as the mediator, and Student Competency Development (SCD) as the dependent variable.

The results indicated that AIC had a significant and positive effect on EL ($B = 0.9725$, $SE = 0.0815$, $t = 11.93$, $p < 0.001$), suggesting that greater academic–industry collaboration is associated with more robust experiential learning opportunities. In turn, EL exhibited a strong and significant effect on SCD ($B = 0.9728$, $SE = 0.0207$, $t = 46.99$, $p < 0.001$), indicating that students who engaged in more intensive experiential learning reported higher competency development outcomes.

The indirect effect of AIC on SCD via EL was 0.9460, with a 95% bootstrapped confidence interval of [0.7833, 1.1229], which does not include zero, confirming the presence of a statistically significant mediation effect. The completely standardized indirect effect was 0.4020, which represents a moderate-to-strong effect size by conventional standards. Notably, the direct effect of AIC on SCD remained significant even after accounting for EL ($B = 0.3685$, $SE = 0.0426$, $t = 8.65$, $p < 0.001$),

indicating that experiential learning partially, rather than fully, mediates this relationship.

These findings validate Hypothesis H3 and underscore the critical role of experiential learning as a psychological and pedagogical mechanism through which institutional collaboration with industry enhances student development. In other words, AIC does not automatically lead to increased student competencies; instead, its impact is realized through the experiential learning processes it facilitates. By operationalizing experiential learning as a mediating variable, this analysis bridges the structural and process domains of the model and provides clear empirical evidence of how learning environments shaped by industry engagement promote individual growth.

Furthermore, the partial nature of the mediation suggests that other mechanisms—such as motivation, self-efficacy, or institutional culture—may also play a role, inviting future exploration. Nonetheless, the present study affirms that experiential learning constitutes a powerful channel through which academic–industry collaboration translates into meaningful student outcomes.

To examine Hypothesis H4, which proposes that institutional support moderates the relationship between academic–industry collaboration (AIC) and student competency development (SCD), a hierarchical regression and interaction effect analysis were conducted. The moderation model incorporated AIC as the predictor, institutional support (IS) as the moderator, and the interaction term ($AIC \times IS$) to determine whether the strength of the relationship between collaboration and competency development varies depending on the level of institutional support present in vocational colleges.

In the baseline regression model, AIC was shown to have a strong positive effect on SCD ($B = 0.959$, $\beta = 0.976$, $t = 88.35$, $p < 0.001$). When IS was added to the model (Model 2), its direct effect on SCD was marginally negative and not statistically significant at the conventional level ($B = -0.065$, $\beta = -0.049$, $t = -1.90$, $p = 0.058$), suggesting that IS alone may not directly influence SCD in a consistent way across institutions. However, when the interaction term ($AIC \times IS$) was introduced in Model 3, the coefficient became positive and statistically significant ($B = 0.313$, $\beta = 0.381$, $t = 20.87$, $p = 0.012$), confirming the presence of a moderating effect.

These findings support Hypothesis H4 and indicate that institutional support significantly enhances the effect of academic–industry collaboration on student competency development. In other words, the positive influence of AIC on SCD is stronger in institutions where institutional support mechanisms—such as flexible governance structures, faculty incentives, dedicated cooperation offices, and adequate resource provision—are more robust. Conversely, in institutions with limited support systems, the benefits of collaboration may be diluted, or even compromised by operational inefficiencies or fragmented policies.

Theoretically, this finding highlights the role of organizational conditions in shaping educational outcomes and confirms the value of integrating system-level variables into educational impact models. Practically, it offers actionable insights for institutional leaders and policymakers: strengthening institutional support frameworks is not merely desirable, but essential for realizing the

full value of industry-aligned educational initiatives. Effective collaboration is not self-executing; it must be scaffolded by systems that enable, sustain, and amplify its intended outcomes.

To explore Hypothesis H5, which suggests that the strength of the relationship between academic–industry collaboration and student competency development may vary across institutional and industrial contexts, a multi-group structural equation modeling approach was utilized. This analytic technique enables comparison of path coefficients across predefined subgroups, allowing for examination of whether structural relationships are invariant across different categories of interest—in this case, institutional type and industry collaboration type.

Before conducting group comparisons, measurement invariance was established across subgroups by testing for configural, metric, and scalar equivalence. Configural invariance confirmed that the same basic model structure was valid across groups, while metric and scalar invariance tests ensured that factor loadings and item intercepts were sufficiently similar to justify structural path comparisons. Once invariance was confirmed, z-tests were performed to compare standardized path coefficients across subgroups.

The results revealed statistically significant differences in the effect of AIC on SCD across institutional types. Among students enrolled in national-level “Double High Plan” vocational colleges, the standardized path coefficient from AIC to SCD was $\beta = 0.901$ ($B = 1.045$, $t = 20.9$, $p < 0.001$), whereas in provincial key vocational colleges, it dropped to $\beta = 0.735$ ($B = 0.847$, $t = 15.2$, $p < 0.001$), and further declined in local general vocational colleges to $\beta = 0.641$ ($B = 0.692$, $t = 10.18$, $p < 0.001$). These differences were statistically significant and substantively meaningful, indicating that the strength of the collaboration–competency relationship is conditioned by institutional resource capacity, governance flexibility, and embeddedness in industrial ecosystems.

In addition, subgroup analysis by industry type also revealed heterogeneity. For students participating in manufacturing-based collaborations, the AIC → SCD path coefficient was strongest ($\beta = 0.891$), reflecting the tangible, task-specific nature of learning opportunities in that sector. In contrast, the coefficient for information technology collaborations was slightly lower ($\beta = 0.812$), followed by logistics and supply chain ($\beta = 0.754$), and hospitality and tourism ($\beta = 0.698$). The “Other” industries group exhibited the weakest path strength ($\beta = 0.615$), possibly due to lower integration of practical learning into academic structures or less stable institutional partnerships.

These findings support sub-hypotheses H5a and H5b, confirming that institutional and industrial conditions influence the effectiveness of collaboration mechanisms. Theoretically, this reinforces the argument that educational impact models must be sensitive to context; the same mechanism may yield different results depending on the institutional ecology and sectoral logic. Practically, this suggests the need for differentiated collaboration strategies tailored to institutional strengths and sectoral realities.

The variability in path strength across groups highlights the importance of capacity building in

less resourced institutions and the alignment of curricula with industry-specific competency models. For policymakers, the results suggest that one-size-fits-all mandates for collaboration are insufficient; instead, policies should provide adaptive frameworks that allow institutions to calibrate their strategies based on localized needs and sectoral opportunities.

Discussion

This study aimed to explore the impact of academic–industry collaboration (AIC) on student competency development (SCD) within the context of Chinese vocational education, while examining the mediating role of experiential learning (EL) and the moderating effect of institutional support (IS). The findings offer several noteworthy implications that reinforce, extend, and challenge existing theoretical frameworks in vocational education and training (TVET), particularly those grounded in experiential learning theory and institutional systems theory.

Firstly, the results provide strong empirical support for the assertion that academic–industry collaboration positively influences student competency outcomes. This aligns with previous studies which emphasized that structured cooperation between educational institutions and industry partners contributes significantly to student employability and workplace readiness (Chen, Lv, & Wang, 2020; Kee, 2024). However, unlike earlier models that conceptualize collaboration as a primarily structural feature—often measured in terms of the number of enterprise partners or internship placements—this study emphasizes the qualitative dimension of collaboration. The significant path coefficient between AIC and SCD suggests that effective collaboration is not just about institutional linkage, but about deep pedagogical integration (Lü, Wu, & Shouse, 2022).

More importantly, this study contributes to the validation and contextual application of Kolb’s (1984) experiential learning theory within vocational settings. The partial mediation of EL in the AIC–SCD relationship empirically confirms the central tenet of experiential learning: that knowledge is constructed through a cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation. In this study, students who reported higher involvement in real-world projects and enterprise-led activities exhibited significantly higher competency development. This supports the view that experiential learning is not merely an instructional technique but a key psychological mechanism by which institutional collaboration becomes transformative (Kolb, 1984).

Moreover, the study identifies institutional support as a statistically significant moderator, enhancing the effect of AIC on SCD in environments where governance, resources, and leadership alignment are robust. This resonates with institutional systems theory, which argues that organizations are embedded within broader ecological and policy environments that either constrain or enable functional performance (Scott, 2001). The finding that the AIC–SCD relationship was stronger in institutions with higher levels of institutional support reinforces the notion that collaboration alone is

insufficient unless it is scaffolded by organizational conditions that facilitate implementation and sustain participation. This nuance advances earlier research that viewed institutional factors as background variables rather than active enablers (Lucietto, Peters, & Anderson, 2021).

Additionally, this study responds to the growing call in educational research for contextual sensitivity. The subgroup analysis revealed significant variation across institutional types and industry sectors in the strength of the AIC → SCD pathway. Students from national “Double High Plan” institutions demonstrated stronger path coefficients than their peers from provincial or local vocational colleges. Similarly, collaborations within the manufacturing and IT sectors produced more robust outcomes than those in logistics, tourism, or undefined categories. These findings suggest that educational outcomes are not solely determined by internal pedagogical quality, but also by external alignment with industry structures and institutional readiness (Zuo, Huang, & Ye, 2024). Thus, collaboration models need to be adapted rather than standardized across diverse educational and industrial contexts.

Theoretically, the integration of structural, process, and environmental dimensions into one empirical framework represents a substantial advancement over unidimensional models. While prior literature has emphasized either structural input (AIC) or learning output (SCD), this study introduces a comprehensive logic model that bridges structural engagement, pedagogical mediation, and contextual modulation. It moves beyond the classic input–output paradigm and instead supports a systems-based “structure–process–outcome” perspective (Fornell & Larcker, 1981; Hu & Bentler, 1999). Such a model provides a more holistic lens for analyzing how institutional arrangements lead to human capital formation in vocational education.

Finally, this study opens several avenues for future research. While the data demonstrate robust cross-sectional relationships, longitudinal studies are needed to track how collaboration and learning processes evolve over time. Future research could also incorporate qualitative methods—such as interviews with students, teachers, and enterprise mentors—to unpack the lived experiences behind statistical relationships. Moreover, the model could be extended to include additional moderating or mediating variables, such as student self-efficacy, digital literacy, or policy alignment, which may further influence the effectiveness of collaboration.

In summary, the findings of this study contribute to a richer, more nuanced understanding of how academic–industry collaboration functions within vocational education. They underscore the importance of experiential learning as a pedagogical bridge, institutional support as a contextual amplifier, and adaptive strategy as a necessary feature of collaboration design. These insights not only deepen theoretical discourse but also inform evidence-based reform practices that aim to build more responsive, equitable, and future-ready TVET systems.

Conclusion

This study set out to examine the effects of academic–industry collaboration (AIC) on student competency development (SCD) in Chinese vocational education, while accounting for the mediating role of experiential learning (EL) and the moderating effect of institutional support (IS). The empirical evidence presented in the previous chapter offers compelling support for the proposed structural framework and advances our understanding of how multi-level factors interact to shape educational outcomes in practice-based learning environments.

The first key finding confirms that academic–industry collaboration, defined by mechanisms such as joint curriculum design, co-teaching, internship partnerships, and mutual governance structures, significantly and positively impacts student competency development. This relationship was further reinforced by the strong effect of industry involvement, which captures the extent to which enterprise professionals contribute to pedagogy, project mentorship, and work-based assessments. These findings align with Hypotheses H1 and H2 and validate previous assertions that institutional alignment with industry is not only desirable but instrumental in cultivating work-ready graduates.

Second, the results demonstrate that experiential learning serves as a robust mediating mechanism in the AIC–SCD relationship. Students who engage in higher levels of experiential learning—characterized by active participation in real-world projects, guided reflection, concept abstraction, and applied practice—report significantly higher competency outcomes. The mediation analysis supports Hypothesis H3 and affirms that collaboration alone is insufficient to ensure student growth unless it is anchored in a high-quality experiential learning process. This finding elevates the role of learning design and pedagogical integration in the successful translation of structural partnerships into developmental gains.

Third, institutional support was shown to moderate the relationship between AIC and SCD. The positive impact of collaboration was significantly more pronounced in institutions with well-established support mechanisms, such as dedicated collaboration offices, strategic leadership commitment, adequate resources, and faculty incentive systems. The interaction effect confirms Hypothesis H4 and highlights the role of systemic enablers in shaping the effectiveness of collaboration. This is particularly relevant in the Chinese vocational context, where institutional variation remains high across regions and sectors.

Finally, multi-group comparisons revealed notable heterogeneity in the strength of AIC → SCD pathways across both institutional and industry sectors. Specifically, students from national-level “Double High Plan” colleges and those participating in manufacturing and IT-based industry partnerships reported stronger developmental outcomes than those from general local colleges or those involved in lower-integration industry collaborations. These results support Hypotheses H5a and H5b and illustrate that context matters: the same collaborative mechanisms yield different results depending on organizational readiness and sectoral alignment.

In sum, this study substantiates an integrated model of collaboration, process, and institutional context. It affirms that while AIC is a valuable structural asset, its impact is realized through pedagogical mechanisms and shaped by environmental conditions.

The findings of this study yield several significant theoretical implications that contribute to the academic discourse on vocational education, experiential learning, and educational collaboration. By systematically integrating structural, pedagogical, and institutional dimensions into a single empirical model, this research enriches existing frameworks in at least three important ways.

First, this study advances the literature on academic–industry collaboration (AIC) by moving beyond the structural perspective to explore the processual mechanisms through which such partnerships influence student outcomes. While previous research has often focused on quantifying partnerships or describing governance models, few have empirically examined how collaboration becomes pedagogically consequential. This study demonstrates that the effectiveness of AIC is not inherent in its presence but is contingent upon how collaboration is operationalized in the learning experience. This represents a theoretical shift from input–output models toward an integrative “input–process–outcome” logic that captures the full educational transformation pathway.

Second, the study reinforces and extends Kolb’s (1984) experiential learning theory by empirically validating its mediating role in the vocational education context. While experiential learning has been widely advocated in practice, there remains limited empirical evidence supporting its role as a causal mechanism in structured collaboration environments. This study confirms that EL serves as a critical psychological and instructional bridge between institutional collaboration and student development. It also provides a contextualized application of Kolb’s learning cycle—concrete experience, reflective observation, abstract conceptualization, and active experimentation—within the realities of Chinese vocational education, where practical exposure and pedagogical quality are often uneven. By embedding EL within a broader structural model, the study demonstrates its theoretical significance beyond isolated classroom applications.

Third, this study contributes to systems theory in education by introducing institutional support (IS) as a cross-level moderating variable. The finding that IS amplifies the positive effect of AIC on SCD offers theoretical insights into the role of organizational context in mediating collaboration outcomes. While the literature has acknowledged that institutional conditions matter, few empirical models have explicitly treated IS as a moderator. This study illustrates how governance capacity, resource availability, and strategic alignment can shape the translation of collaborative mechanisms into measurable student benefits. In doing so, it underscores the need for education theory to account for system-level variables that structure and enable pedagogical processes.

Moreover, the identification of significant subgroup differences in AIC effectiveness contributes to emerging scholarship on contextual sensitivity in educational interventions. The variation across institutional types and industry sectors suggests that educational theories of collaboration must

be elastic enough to accommodate ecological variation. The “one-size-fits-all” theoretical models are increasingly inadequate for capturing the complexity of modern vocational education systems. Instead, this study supports a contingent view of collaboration, where outcomes depend on the alignment between institutional readiness, sectoral demands, and student characteristics.

Finally, the integrative model proposed in this study synthesizes elements from organizational theory, pedagogical theory, and human capital theory. It offers a theoretically grounded explanation of how collaborative education models can function as a developmental ecosystem. This ecosystem perspective recognizes that student development is not merely a function of what happens in the classroom, but also of the institutional, industrial, and instructional systems in which that classroom is embedded.

In sum, the study offers theoretical advancement by constructing and empirically validating a multi-dimensional model of vocational education collaboration. It emphasizes the interplay of structure, process, and environment in shaping educational outcomes, and in doing so, sets the stage for more sophisticated theorization of collaborative learning in technical and vocational education and training (TVET) settings.

Beyond its theoretical contributions, this study provides important practical implications for institutional leaders, educators, and policymakers engaged in the reform and advancement of vocational education. By identifying both the mechanisms and contextual enablers that determine the effectiveness of academic–industry collaboration (AIC), the findings offer an evidence-based roadmap for designing more impactful and sustainable cooperative education strategies.

For vocational institutions, one of the most salient takeaways is the need to embed collaboration within the core structures of the educational system. Rather than treating AIC as a peripheral or one-off engagement, institutions should institutionalize partnerships through the development of formal cooperation offices, long-term enterprise alliances, and mechanisms for joint governance and curriculum design. The study shows that collaboration alone does not produce significant student outcomes unless accompanied by meaningful experiential learning. Therefore, institutional leaders must ensure that collaborative arrangements are pedagogically integrated into courses and assessment systems, not merely confined to internships or symbolic industry events.

Moreover, institutions should prioritize the enhancement of experiential learning design. This includes the adoption of project-based learning, dual mentorship models (combining faculty and enterprise mentors), and the inclusion of enterprise-defined competencies in course objectives. Given that experiential learning emerged as a central mediator in the relationship between collaboration and outcomes, attention must be paid not only to the content of what students are learning, but how they are learning it and within what real-world contexts. Investment in simulation labs, rotation-based workplace experiences, and industry-led workshops can serve to reinforce the authenticity and transferability of student learning.

From a human resource perspective, faculty development is critical. Institutions must support their teaching staff to acquire and integrate practical, industry-relevant skills. This can be done through faculty internships in enterprises, co-teaching with industry professionals, and performance incentives tied to successful student outcomes in collaborative programs. Without dual-qualified or “dual-professional” faculty who can bridge theory and practice, even the most well-intentioned collaborations may struggle to translate into learning gains.

For policymakers, the findings highlight the essential role of institutional support structures in magnifying the effects of collaboration. Government agencies at both national and provincial levels should prioritize funding mechanisms that reward institutions not only for the quantity of collaborations, but for the quality and depth of pedagogical integration. This means shifting away from performance indicators focused on number of agreements signed, and toward metrics that track experiential learning hours, enterprise mentor engagement, and student satisfaction with industry-based components of their education.

Policies should also promote adaptive frameworks that allow institutions with different profiles to design context-specific collaboration models. As the subgroup analysis shows, not all institutions are equally positioned to engage in deep collaboration. Therefore, differentiated policy support—such as targeted grants for under-resourced colleges or sector-specific competency frameworks—can help reduce disparity and foster more equitable outcomes.

For the industry sector, this study reinforces the value of sustained, structured participation in vocational education. Enterprises should be encouraged to move beyond passive recruitment to active co-development of talent pipelines. Their participation in curriculum co-design, assessment, and real-time feedback loops can significantly enhance the relevance and employability of graduates. Incentives such as tax breaks, government partnership recognition, or innovation vouchers may be used to promote enterprise participation at scale.

Finally, from the student perspective, the results imply that students should be guided and supported to actively engage in experiential learning opportunities. Institutions must cultivate not just exposure, but intentional learning mindsets—through guided reflection, career advising, and integration of EL experiences into assessment systems. Students should be empowered as co-agents in the collaboration process, with structured feedback channels and mechanisms to voice their learning experiences.

In summary, this study offers actionable recommendations across multiple stakeholder groups. The empirical model validated herein provides a practical blueprint for vocational institutions aiming to align educational offerings with industry needs, while ensuring that students are not passive recipients but active constructors of their professional competencies. It further underscores that successful academic–industry collaboration is not the result of structural alignment alone, but of pedagogical design, institutional support, and contextual intelligence.

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