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A Study on Core Professional Competencies of Higher Vocational Civil Architecture Students

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Abstract

Background and Aim: The rapid digital transformation of the construction industry has placed new demands on higher vocational education to develop civil architecture students equipped with both technical expertise and core professional competencies. However, existing curricula often fall short in areas such as digital literacy, communication, and problem-solving, leading to a mismatch between graduate capabilities and industry needs. This study aims to construct a tailored competency framework, evaluate the current development status among students, identify key influencing factors, and offer practical recommendations to support educational reform and workforce alignment.

Materials and Methods: A quantitative research design was employed to develop and validate a five-dimensional framework of core professional competencies, including ethics, communication, problem-solving, digital skills, and self-development. A structured questionnaire was distributed to 472 civil architecture students across three vocational colleges. The data were analyzed using SPSS and AMOS for descriptive statistics, group comparison, correlation analysis, and structural equation modeling to explore the relationships between educational processes, practical experiences, personal backgrounds, and competency formation.

Results: Findings indicate that students perform strongest in professional ethics and responsibility awareness, while information technology literacy remains relatively weak. Significant differences in competency levels were observed based on gender, grade, and internship experience, with practical experience notably enhancing digital skills and problem-solving abilities. Structural equation modeling confirmed the significant and interactive effects of educational processes, practical experience, and individual background on core competencies.

Conclusion: The study verifies the multidimensional structure of core professional competencies in higher vocational civil architecture students and reveals the complex influence of educational and experiential factors. These insights enrich the application of competency theory in vocational education and provide a scientific foundation for optimizing talent development aligned with industry needs.

Keywords: Core Professional Competencies; Higher Vocational Education; Civil Architecture; Competency Assessment; Educational Reform

Introduction

With the ongoing advancement of China's "New Urbanization" strategy and large-scale infrastructure development, the construction industry is rapidly transitioning from a traditional labor-intensive model toward modernization and intelligent transformation. This shift places unprecedented demands on the comprehensive qualities of civil and architectural engineering professionals. Under the guidance of national policies such as the Action Plan for Improving the Quality of Vocational Education (2020–2023) and the Implementation Plan for Vocational Education Reform, higher vocational education is entrusted with the historic mission of serving industrial development and cultivating job-ready talent. For civil architecture programs, which are traditional and technically intensive, enhancing students' core professional competencies beyond technical skills has become a pressing academic and practical issue.

"Core professional competencies" not only include critical non-cognitive abilities such as work ethics, responsibility, communication skills, teamwork, digital literacy, and problem-solving, but also represent an integrated capability structure oriented toward occupational readiness and lifelong learning. In current vocational education practice, due to an overemphasis on technical training and a relative neglect of competency cultivation, many civil architecture students, though technically proficient, often struggle in real workplace settings due to poor communication, weak project awareness, and limited adaptability. Therefore, exploring the structural features, developmental status, and influencing mechanisms of core professional competencies among civil architecture students holds significant theoretical and practical value.

Although substantial research has been conducted in the field of professional competencies, most studies focus on general populations or basic education contexts. There is a lack of targeted theoretical

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models and systematic empirical investigations for vocational education, particularly in engineering-oriented disciplines like civil architecture. On one hand, the concept of "core professional competencies" remains ambiguously defined in existing literature, with inconsistent research frameworks that limit direct applicability to vocational training. On the other hand, empirical research is largely based on subjective perceptions or educator perspectives, lacking student-centered and industry-aligned data. Furthermore, limited attention has been given to the educational process variables—such as curriculum content, internship experiences, and faculty resources—that influence the formation of professional competencies, resulting in weak foundations for educational interventions.

This study, therefore, adopts a vocational education perspective and takes students in civil architecture programs as the primary research subject. It aims to construct a competency framework aligned with industry demands, measure the current competency levels of students, and identify key influencing factors, thereby providing theoretical and empirical support for educational reform and policy design in higher vocational institutions.

To address the above-mentioned problems, this study adopts a comprehensive approach to define and explore the core professional competencies required for higher vocational students in civil architecture programs. First, the study conducts an extensive literature review, integrating insights from both domestic and international research, as well as analyzing the actual competency needs of the construction industry, to clarify the conceptual boundaries and structural dimensions of these competencies. Building on this theoretical foundation, a structured evaluation framework is developed to guide empirical investigation.

Subsequently, a large-scale questionnaire survey is implemented among students in civil architecture programs across several higher vocational institutions. This empirical phase is designed to quantitatively assess students' competency levels in key areas such as professional ethics, communication, problem-solving, digital literacy, and self-development. The data collected provides a basis for analyzing current developmental patterns and identifying existing competency gaps.

In the third phase, statistical techniques, including factor analysis and structural equation modeling, are employed to explore the relationships between students' competencies and influencing factors such as educational processes, internship experiences, personal background, and learning motivation. These analyses help to uncover the underlying mechanisms that shape competency development and validate the proposed competency framework.

Finally, the study offers a set of evidence-based recommendations aimed at guiding educational reform in vocational institutions. These include optimizing curriculum content, innovating teaching methods, enhancing collaboration with industry, and improving evaluation systems. Through this integrated research strategy, the study not only addresses the theoretical gaps in competency research but also provides practical solutions for improving talent cultivation in the field of civil architecture vocational education in China.

Objectives

This study aims to achieve the following interconnected objectives to address the challenges identified in vocational education for civil architecture:

Construct a Theoretical Framework of Core Professional Competencies: Clarify the definition and structure of core competencies specific to civil architecture students, based on industry needs and existing research, to lay a theoretical foundation for competency assessment.

Empirically Assess Students' Competency Development Status: Develop and apply a measurement tool to evaluate students' core competencies across key dimensions, and analyze differences based on academic background and practical experiences.

Identify Key Influencing Factors: Explore how educational processes, individual characteristics, and practical training experiences shape competency development using structural equation modeling and statistical analysis.

Provide Practice-Oriented Educational Recommendations: Propose targeted strategies for curriculum reform, instructional innovation, and industry collaboration to support competency enhancement and improve vocational training outcomes.

Literature review

Definition of Core Professional Competencies and Construction of Evaluation Frameworks

In recent educational research, "core professional competencies" have increasingly been recognized as a critical metric for evaluating the quality of vocational education and student development. Wang and

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Zhong (2017), using a fuzzy comprehensive evaluation method, constructed a multi-dimensional assessment system for student competencies, providing a methodological foundation for quantitative competency analysis. Zu (2018), focusing on students in civil engineering-related majors, emphasized that professional competencies should encompass not only ethics and behavioral norms but also soft skills such as communication, collaboration, and a sense of responsibility. These competencies, she argued, should be embedded throughout the educational process.

While these studies provide theoretical support for defining core competencies, they also reveal certain limitations. First, they often overlook the heterogeneity of industry demands, which differ significantly across professions, rendering unified indicators insufficient. Second, there is a lack of assessment tools that are well-aligned with enterprise expectations, limiting the applicability and scalability of existing models in professional training contexts.

Talent Development Models in Civil Architecture Vocational Programs

Scholars have explored various approaches to improving talent development in civil architecture programs within vocational colleges. Liu (2022) pointed out that such programs face challenges, including weak practical training and insufficient industry-academic collaboration. He advocated for a "project-driven + task-oriented" model to enhance students' job readiness. Qi and Chen (2013) proposed the "1-2-3" training model, comprising one core, two pathways, and three integrations, to strengthen the alignment between professional skills and core competencies.

Similarly, Zeng (2019) explored an “integration-entry-enhancement” model to incorporate industry standards into coursework and improve students’ occupational competence. Zhang (2017) and Qi and Yang (2016) conducted practical research on experiential teaching methods, finding that they significantly boost student motivation and professional awareness—an effective strategy for developing core competencies.

Although existing studies offer valuable insights into teaching reforms and curriculum design, they often lack an integrated pathway that systematically incorporates core competencies into educational goals, course structures, and evaluation mechanisms.

Industry Needs and Competency Structures

The formation of core professional competencies must be closely aligned with real-world occupational demands. Feng (2019) emphasized that the construction industry expects a "skills + soft abilities" talent standard, valuing not only technical expertise but also teamwork, communication, and on-site adaptability—areas where vocational education often falls short. He (2020), from the perspective of internationalization under the “Belt and Road” initiative, argued for cultivating globally competent professionals with cross-cultural communication and project management skills.

Xiao and Liu (2013), drawing on industry-academia cooperation experience, suggested that improving off-campus practical training is crucial for bridging competency gaps. They emphasized that real project environments are ideal for developing problem-solving and organizational abilities. These studies underscore the necessity of designing competency models grounded in authentic job requirements.

Influence of Faculty Structure and Practical Teaching on Competency Development

The cultivation of core professional competencies depends not only on curriculum content but also on faculty structure and instructional organization. Zhou (2019) pointed out that the current "dual-teacher" structure in civil architecture vocational programs is often underdeveloped, with a shortage of instructors proficient in both theory and practice. Zeng (2019) also criticized the dominance of theoretical instruction and called for task-based practical teaching models to better engage students’ sense of professional identity and responsibility.

Such research highlights the importance of establishing multidisciplinary teaching teams and career-contextualized learning environments, both of which are essential for systematically fostering professional competencies.

In summary, existing literature provides rich perspectives on talent development, competency frameworks, and teaching innovation in civil architecture vocational education. However, notable gaps remain: (1) the absence of a systematic, profession-specific model for core professional competencies; (2) limited empirical studies centered on student perspectives and data-driven measurement; and (3) a lack of mechanisms linking educational strategies with actual industry needs. Therefore, this study seeks to bridge these gaps through theoretical model construction, empirical validation, and strategic recommendations to advance the quality and relevance of vocational education.

Conceptual Framework

Defining the Constituent Dimensions of Core Professional Competencies

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Core professional competencies refer to the essential integrated qualities that enable individuals to competently perform job tasks, adapt to occupational changes, and achieve sustainable career development within a specific professional domain. These competencies encompass not only professional skills and cognitive abilities but also moral integrity, interpersonal communication, teamwork, information processing, innovation awareness, and learning capabilities. Within the context of higher vocational education, core professional competencies should transcend the traditional "professional ethics plus skills training" paradigm and evolve into a comprehensive ability set deeply integrated with job competency requirements and oriented toward complex work scenarios.

Drawing upon relevant domestic and international studies as well as the Ministry of Education's vocational education standards, this study categorizes core professional competencies into five fundamental dimensions: (1) Professional Ethics and Responsibility Awareness: including professional spirit, dedication, legal compliance, and safety consciousness, forming the foundation for normative professional conduct; (2) Communication and Collaboration Skills: emphasizing effective information exchange, teamwork coordination, and conflict resolution among colleagues, supervisors, and clients; (3) Problem-solving and Critical Thinking Ability: the capacity for logical reasoning, technical judgment, and decision optimization when encountering on-site construction or emergent issues; (4) Information Technology and Digital Literacy: mastery of basic software applications, data processing, and adaptability to digital technologies such as smart construction sites and BIM modeling; (5) Self-development and Learning Ability: focusing on career planning awareness, reflective capacity, and sustained motivation for lifelong learning to meet evolving industry knowledge and technology demands.

These dimensions are interrelated and function synergistically in practice, constituting a holistic competency structure that provides a theoretical foundation for subsequent model construction.

To construct a professional and industry-aligned theoretical framework of core competencies, this study conducts a targeted analysis of job competency requirements in higher vocational civil architecture programs.

As an engineering-intensive field, the civil architecture industry demands not only strong technical proficiency but also capabilities such as professional discipline, inter-professional collaboration, and on-site adaptability. Key positions—such as site engineers, document controllers, surveyors, and quality managers—require individuals to manage cross-functional coordination, oversee safety, process data, and handle dynamic, real-world challenges.

→ Job Analysis Results reveal the following core abilities expected of new graduates:

Execution and Compliance: Understanding and implementing technical instructions and drawings with precision.

Cross-Disciplinary Communication: Facilitating clear information flow among diverse stakeholders.

On-site Adaptability and Safety Awareness: Responding flexibly to environmental or technical changes while ensuring safety compliance.

Basic Data Management: Handling construction documentation, reporting, and digital records effectively.

Lifelong Learning and Technological Adaptation: Continuously updating knowledge and tools to stay aligned with industry evolution.

→ These findings inform:

→ Objective 1: The construction of a theoretical framework by aligning educational targets with occupational expectations.

→ Objective 3: The identification of influencing factors by connecting job demands with required educational interventions (e.g., curriculum focus, internship design, teaching strategies).

Thus, this job competency analysis serves as a foundational step that bridges empirical industry needs and educational model design, ensuring that the proposed competency framework is both practice-oriented and theoretically grounded.

Conceptual Model Construction and Variable Hypotheses

Building on the theoretical analysis and job requirement synthesis, this study proposes a conceptual structural model with students' core professional competencies as the dependent latent variable, influenced by educational process variables, individual background variables, and practical experience variables. The model aims to elucidate the pathways and internal mechanisms shaping competency development.

In this model, core professional competencies are represented as a latent construct comprising five measurement dimensions: professional ethics and responsibility, communication and collaboration, problem-solving ability, information technology literacy, and self-development capability. Explanatory

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variables include educational process factors such as curriculum alignment, diversity of teaching methods, and proportion of dual-qualified instructors; individual background factors including gender, grade level, family educational background, and learning motivation; and practical experience factors encompassing frequency of off-campus internships, project-based training, and enterprise mentor guidance.

Based on this framework, the following hypotheses are proposed:

H1: Educational process variables exert a significant positive effect on students' core professional competencies.

H2: Individual background variables result in structural differences in students' core professional competencies.

H3: Practical experience variables mediate the enhancement of students' core professional competencies.

H4: Interaction effects may exist between educational process and practical experience variables, jointly influencing competency development.

This model provides a clear theoretical pathway for questionnaire design, data analysis, and empirical validation, laying a structured foundation for building a competency-centered evaluation system in vocational education.

Methodology

Research Design and Approach

This study adopts a quantitative empirical research approach, integrating a theoretical framework construction with data analysis to systematically investigate the current status and influencing mechanisms of core professional competencies among higher vocational students in civil architecture. The research design is based on the Structural Equation Modeling (SEM) framework, clearly defining dependent and independent variables as well as their internal relationships, ensuring a cohesive integration of theory and empirical evidence. Specifically, the study follows four steps: (1) constructing theoretical models and hypotheses based on literature review and industry surveys; (2) designing a scientifically sound questionnaire covering all core competency dimensions and influencing factors; (3) selecting representative vocational college students as the sample for large-scale data collection; and (4) conducting reliability, validity tests, and model verification using statistical analysis software to ensure the scientific rigor and credibility of the conclusions.

The study strives to balance sample representativeness, measurement tool validity, and analytical rigor to ensure that findings possess both theoretical significance and practical applicability.

Sample Selection and Data Sources

The study selected students from civil architecture-related majors in three representative vocational colleges in eastern China as the research population. Stratified random sampling was employed to ensure broad representativeness. The sample includes students across different grades, genders, and urban-rural backgrounds to realistically reflect the student population. Data were collected during the fall semester of 2024, with 500 questionnaires distributed and 472 valid responses recovered, yielding an effective response rate of 94.4%.

Table 1 summarizes the basic characteristics of the sample:

Sample Attribute	Category	Frequency	Percentage (%)
Gender	Male	310	65.7
	Female	162	34.3
Grade	Freshman	128	27.1
	Sophomore	152	32.2
	Junior	192	40.7

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Sample Attribute	Category	Frequency	Percentage (%)
Family Residence	Urban	270	57.2
	Rural	202	42.8

Survey Instrument and Indicator System Design

A structured questionnaire was developed as the primary data collection tool, comprising three sections: the first gathers respondents' demographic information; the second assesses the five dimensions of core professional competencies through multiple Likert-scale items (1 = strongly disagree, 5 = strongly agree); the third addresses influencing factors including educational process variables (e.g., curriculum satisfaction, diversity of teaching methods), practical experiences (e.g., internship frequency, project participation), and personal motivation.

Table 2 An example of the competency indicator system

Dimension	Sample Indicators	Number of Items
Professional Ethics & Responsibility	Adherence to professional norms, safety awareness	5
Communication & Collaboration	Effective teamwork and problem-solving	6
Problem-Solving Ability	Independent analysis and solution proposal	5
Information Technology Literacy	Proficiency in BIM and other professional software	4
Self-Development Ability	Career planning and continuous learning	5

The questionnaire was refined through expert consultation and pilot testing to ensure content validity and clarity of expression.

Data Collection and Processing Methods

Data were collected via a combination of paper-based and electronic questionnaires to optimize response rates and data quality. Following the collection, data cleaning was performed to remove responses with anomalous completion times, duplicates, and high rates of missing values. Reverse coding and normalization were applied to relevant items to maintain scale consistency.

Data analysis was conducted using SPSS and AMOS software. Procedures included descriptive statistics, reliability analysis (Cronbach's alpha), validity analysis (exploratory and confirmatory factor analyses), correlation testing, and structural equation modeling with path analysis. Model fit was evaluated using multiple indices, including the chi-square test, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA), ensuring the model's scientific robustness.

Reliability and Validity Testing

To ensure the reliability and validity of the measurement instrument, multiple tests were conducted. Cronbach's alpha coefficients assessed internal consistency, yielding an overall alpha of 0.91 for the core competency scale, with each dimension exceeding 0.80, indicating high reliability. Exploratory Factor Analysis (EFA) supported structural validity, with a Kaiser-Meyer-Olkin (KMO) measure of 0.89 and a significant Bartlett's Test of Sphericity ($p < 0.001$), confirming suitability for factor analysis. Confirmatory Factor Analysis (CFA) further validated the theoretical model structure, with model fit indices meeting or exceeding industry standards (CFI = 0.95, TLI = 0.93, RMSEA = 0.05), confirming construct validity.

Table 3 summarizes the reliability and validity test results:

Indicator	Value	Interpretation
Cronbach's α (Overall)	0.91	High internal consistency
Cronbach's α (Dimensions)	0.82–0.88	Acceptable reliability for all dimensions

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Indicator	Value	Interpretation
KMO	0.89	Suitable for factor analysis
Bartlett's Test p-value	<0.001	Significant inter-variable correlations
CFI	0.95	Excellent model fit
TLI	0.93	Good model fit
RMSEA	0.05	Acceptable error margin

In summary, the questionnaire and data processing methods employed in this study demonstrate high scientific rigor and reliability, providing a solid foundation for subsequent empirical analyses.

Results

Addressing Objective 1: Constructing a Theoretical Framework of Core Professional Competencies Aligned with Industry Needs

Through literature analysis, job competency model review, and industry feedback, this study confirmed five core competency dimensions:

Professional ethics and responsibility awareness

Communication and collaboration

Problem-solving and critical thinking

Information technology and digital literacy

Self-development and learning ability

These dimensions reflect both the expectations of the civil architecture industry and the educational goals of higher vocational programs. The competency framework was validated by aligning it with real job roles and tasks, forming the theoretical basis for subsequent empirical measurement and model testing.

Addressing Objective 2: Empirical Measurement of Students' Competency Development Status

Quantitative data collected from 472 valid responses revealed the following mean scores across the five competency dimensions:

Competency Dimension	Mean	Std. Deviation
Professional Ethics	4.12	0.57
Communication & Collaboration	3.85	0.63
Problem Solving	3.78	0.68
Information Technology	3.62	0.72
Self-Development	3.9	0.59

The results show that students rated themselves highest in professional ethics, reflecting a strong awareness of responsibility and norms. However, lower performance in information technology literacy indicates a need for curriculum improvement in digital competencies. Overall, the competency levels were moderate to high, with notable room for growth in applied and digital skills.

Addressing Objective 3: Identifying Key Factors Influencing Competency Development

Group difference analysis (t-tests and ANOVA) showed: Gender: Female students outperformed males in communication and collaboration ($t = 3.12$, $p < 0.01$). Grade level: Seniors scored higher in problem-solving and self-development ($F = 4.56$, $p < 0.01$), showing a growth trend through educational progression. Internship experience: Students with internship experience scored significantly higher in information technology literacy ($t = 4.02$, $p < 0.001$) and problem-solving ($t = 3.67$, $p < 0.001$), confirming the importance of real-world exposure.

Pearson correlation analysis confirmed significant positive relationships among all five competency dimensions, particularly between: Professional ethics and communication ($r = 0.65$), Problem-solving and self-development ($r = 0.58$). These results underscore the interconnected nature of competencies and the value of holistic development.

Structural Equation Modeling (SEM) further validated these findings: The Educational process had a direct effect on competency ($\beta = 0.47$, $p < 0.001$). Practical experience played a mediating role ($\beta = 0.29$, $p < 0.01$). Individual background (gender, grade, etc.) exerted a moderate effect ($\beta = 0.21$, $p < 0.05$). An

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interaction effect between the educational process and practice was observed ($\beta = 0.15$, $p < 0.05$), emphasizing the need for integrated approaches. These findings confirm that competency development is influenced by a combination of structured education, hands-on training, and personal factors.

Addressing Objective 4: Proposing Practice-Oriented Recommendations Based on Empirical Evidence

While full policy recommendations are detailed in the final section, the results provide direct empirical support for the following directions: Enhance digital literacy training through updated curricula and faculty development. Strengthen school-enterprise partnerships to expand internship opportunities. Encourage experiential learning methods to boost problem-solving and communication skills. Develop evaluation systems that integrate ethical, technical, and soft skill assessments. These practice-oriented suggestions are rooted in the empirical results, aligning well with the core needs identified by the industry and the measured competencies of students.

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Discussion

Performance of Core Competency Dimensions: Strengths and Shortcomings in Educational Practice
The study finds that students majoring in civil architecture at higher vocational colleges performed strongest in professional ethics and responsibility awareness, which suggests that existing curricula and training successfully instill a sense of discipline, rule compliance, and occupational commitment. This aligns with the traditional values emphasized in vocational education in China (Wang & Zhong, 2017) and can be viewed as a clear strength in current educational practice.

However, a notable shortcoming lies in students' relatively weak performance in information technology literacy. Despite the construction industry's ongoing shift toward digitalization—exemplified by tools such as BIM (Building Information Modeling) and smart site management systems—vocational programs have not fully adapted to this trend. Many institutions still lack sufficient curriculum content, teaching resources, or qualified faculty to deliver effective digital skills training. This mismatch between industry demand and education provision highlights a critical gap in preparing students for technology-intensive work environments (Feng, 2019).

Thus, while moral and behavioral competencies are being effectively cultivated, there is a pressing need to rebalance curricular emphasis toward technical adaptability and digital proficiency. Without such adjustments, graduates may face increasing challenges in meeting modern industry expectations.

Key Influencing Factors: Educational and Experiential Strengths vs. Structural Inequities

The analysis reveals that educational background (grade level) and practical experience (especially internships) are positively associated with stronger professional competencies. These findings support the effectiveness of progressive training and experiential learning strategies in promoting student growth. For example, senior students outperform juniors in problem-solving and self-development, likely due to their cumulative exposure to both theoretical and practical learning (Qi & Chen, 2013). Likewise, students with internship experience score significantly higher in digital and applied skills, confirming the value of school-enterprise cooperation and real-world engagement (Xiao & Liu, 2013).

However, several limitations and inequalities are also evident. First, gender-based differences—with females outperforming males in communication and collaboration—may suggest an unbalanced focus in soft skill development, or underlying biases in student-teacher interactions (Zu, 2018). Second, not all students have equal access to high-quality internship experiences, which can create opportunity gaps in competency development. Some institutions, particularly in under-resourced regions, may lack stable enterprise partnerships or diversified practice platforms, reducing the scalability and equity of experiential learning.

Therefore, while current systems show potential in integrating theory and practice, their uneven implementation risks leaving portions of the student population underprepared.

Validation of the Theoretical Model: Comprehensive Logic vs. Practical Challenges

The structural equation modeling confirms that the educational process, practical experience, and individual background all exert significant effects on competency development, and that interaction effects between education and practice further enhance outcomes. These findings provide empirical support for the integrated competency model proposed in this study and reinforce the idea that fragmented or one-dimensional reform efforts are unlikely to be effective (Liu, 2022; Zeng, 2019).

Yet, despite its theoretical soundness, the model also faces practical challenges in implementation. For instance, achieving synchronized reform across curriculum, teaching methods, and practice platforms requires substantial institutional coordination, investment in faculty development, and long-term

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partnerships with industry. In many vocational colleges, especially those with constrained resources, the ability to enact such multifaceted reform remains limited.

Moreover, current evaluation systems often focus narrowly on technical performance or course grades, overlooking the interconnected and multidimensional nature of professional competencies. Without proper assessment tools, even well-designed educational reforms may fall short in practice.

In summary, the study validates a robust theoretical approach to talent development, but also points to several structural, institutional, and equity-related constraints that must be addressed to translate theory into sustainable educational improvement.

Conclusion

This study systematically constructed a theoretical framework of core professional competencies for higher vocational students majoring in civil architecture and empirically revealed their current competency status and structural characteristics across five dimensions: professional ethics, communication and collaboration, problem-solving, information technology literacy, and self-development. The findings indicate that students demonstrate relatively strong performance in professional ethics and responsibility awareness, while information technology literacy remains comparatively weak, highlighting the need for enhanced digital skill training within the curriculum. Background factors such as gender, grade level, and internship experience significantly affect competency levels, with practical experience notably promoting improvements in technical application and problem-solving abilities. Structural equation modeling validated the multidimensional influences of educational processes, practical experience, and individual background on core professional competencies and revealed interaction effects between educational processes and practical experience, underscoring the importance of integrated talent development. Overall, this research not only enriches the application of core competency theory within the higher vocational architecture field but also provides empirical evidence for understanding competency formation mechanisms, laying a scientific foundation for the intrinsic development of vocational education.

Recommendation

Strengthen Digital Curriculum Development and Faculty Training

In response to the digital transformation sweeping the construction industry, higher vocational colleges should accelerate the development of digital curriculum systems by systematically incorporating advanced information technologies such as Building Information Modeling (BIM), smart construction site management, and related software operations. This ensures that students acquire essential digital skills necessary for the modern workplace. Additionally, appropriate teaching hardware and software resources should be allocated to provide students with realistic and immersive learning environments. Teachers, as key facilitators of digital education, must enhance their information technology competencies through targeted professional development. Strengthening the expertise and instructional capabilities of dual-qualified faculty will enable an effective integration of theory and practice in course design. This approach helps to address current deficiencies in students' digital literacy and equips them to adapt to the increasingly intelligent and digitized demands of the construction sector.

Deepen School-Enterprise Cooperation and Enrich Practical Training Platforms

Practical training serves as a vital vehicle for cultivating professional competencies. Vocational colleges should actively expand partnerships with enterprises to establish diverse training bases and off-campus internship platforms that increase students' exposure to real project environments. Through project-driven learning and on-site practical exercises, students can substantially improve communication, teamwork, problem-solving, and on-site adaptability, while also fostering a strong sense of professional responsibility. Enhanced coordination between schools and enterprises during internships is crucial, including establishing scientific assessment and feedback mechanisms to ensure the effectiveness of practical training. Such deepened practical engagement not only bridges the gap between academic instruction and industry needs but also cultivates students' comprehensive professional abilities and competitiveness, facilitating smoother employment and career progression.

Innovate Teaching Methods to Promote Experiential and Project-Oriented Learning

Traditional lecture-based instruction struggles to meet the modern vocational education demand for holistic competency development. Higher vocational institutions should actively pursue pedagogical innovation by widely adopting experiential learning and project-based approaches. Methods such as case studies, team collaboration projects, and interdisciplinary integration can stimulate students' learning motivation and initiative, while cultivating their capacity for solving real-world problems and fostering

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innovation. Course content should closely align with industry realities, featuring challenging and practical learning tasks that require students to apply knowledge and skills in authentic or simulated contexts. Teachers should play guiding and mentoring roles, supporting student reflection and synthesis to build a systematic professional competency framework. Such innovative teaching approaches effectively enhance students' comprehensive professional competencies and promote their all-around development.

Establish a Comprehensive Core Competency Evaluation System

To ensure sustained improvement in core professional competencies, vocational colleges need to develop a scientific and systematic evaluation system that organically integrates competency cultivation and assessment, forming a dynamic feedback loop. The evaluation framework should encompass multidimensional indicators, assessing not only mastery of professional knowledge and skills but also soft skills such as ethics, communication, problem-solving, and self-development. Assessment methods should be diversified, combining formative and summative evaluations, and incorporate self-assessment, peer review, and enterprise mentor evaluations to enhance comprehensiveness and fairness. Moreover, evaluation results should be promptly fed back into teaching improvements and student development processes, establishing incentive mechanisms that encourage shared attention to competency growth. A well-designed evaluation system is fundamental to realizing competency-oriented education and plays a critical role in enhancing the quality of vocational education.

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