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The Model of Vocational Learning Management of the Architectural Design Major in Vocational College at Sichuan Province of China

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Abstract

Background and Aim: This research investigates and proposes an effective vocational learning management model for the Architectural Design Major in vocational colleges within Sichuan Province of China, driven by the evolving demands of the architectural industry. Rapid urbanization and economic growth in Sichuan necessitate a skilled workforce capable of addressing challenges in infrastructure, environmental sustainability, and cultural preservation. Traditional vocational education models often fall short in preparing graduates for these dynamic industry requirements, particularly concerning advanced technologies and sustainable practices.
Materials and Methods: The study employed a mixed-methods design, integrating quantitative and qualitative approaches to comprehensively understand current vocational learning management, identify industrial demands, and develop a responsive model. Key objectives included analyzing existing vocational learning management practices, constructing a new model tailored to industrial needs, and evaluating its effectiveness.
Results: Findings reveal that an effective vocational learning management model must prioritize practical teaching, enabling students to apply theoretical knowledge in real-world scenarios to enhance technical proficiency and problem-solving skills. The model emphasizes hands-on training in critical software like computer-aided design and building information modeling, alongside developing essential soft skills such as teamwork and communication. Crucially, it advocates for robust school-enterprise collaboration through internships, co-op programs, and industry-sponsored projects, providing invaluable work experience and networking opportunities that significantly boost graduate employability. Furthermore, the model stresses the importance of continuous curriculum updates to incorporate the latest industry trends, including VR, AR, and sustainable design principles, ensuring students are well-prepared for future challenges. It also promotes a culture of lifelong learning through continuing education and professional development, ensuring graduates remain competitive in a dynamic job market.
Conclusion: The developed model provides a strategic framework for Sichuan's vocational colleges, moving beyond theoretical instruction to cultivate highly competent architectural design professionals. It effectively bridges the gap between academia and industry by promoting deep collaboration with enterprises, fostering practical training, and integrating real-world projects into the curriculum. This approach ensures graduates possess essential practical skills and a professional mindset. By producing job-ready professionals equipped to address modern challenges, the model directly contributes to regional economic development and sustainable urbanization.

Keywords: Vocational Learning Management, Architectural Design, Vocational College, Sichuan Province

Introduction

Around the globe, urbanization is rapidly accelerating, with projections showing nearly 70% of the world's population living in urban areas by 2050. While this trend offers economic opportunities, it also brings significant challenges such as inadequate infrastructure, environmental pollution, and social inequality. China, the world's second-largest economy, has experienced unprecedented economic growth that has fueled its urbanization process. Its urbanization rate now exceeds 50% and is expected to continue rising as industrialization and modernization draw more rural populations into cities. Consequently, educational management is geared towards an integrated administrative model, utilizing

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effective strategies to manage instruction and cultivate critical skills (Phakamach et al., 2023c). This aims to elevate citizen quality, covering both professional competencies and essential 21st-century life skills, thereby aligning with economic development and fostering distinct identities (Han et al., 2023; McGrath & Ramsarup, 2024).

Sichuan Province, situated in southwestern China, is a prime example of this rapid economic growth and urbanization. Its strategic location, abundant natural resources, and rich cultural heritage have been instrumental in its development. Economically, Sichuan is prioritizing regional centers, specialized industries, and increasing urban space and public services. The province is heavily involved in establishing the Chengdu-Chongqing Economic Circle, aiming to create a high-quality growth pole and a new national economic driving force. Sichuan's "14th Five-Year Plan" and long-term goals for 2035 emphasize adapting to new development environments and integrating into new patterns, with a vision to achieve socialist modernization in line with national timelines. The province's "new urbanization" strategy focuses on human-centered development and aims for a permanent resident urbanization rate of over 60% by 2025, with comprehensive new urbanization by 2035. This involves optimizing urban systems, bolstering major cities like Chengdu, and improving urban governance for sustainable growth and a higher quality of life for its residents (Zhang, 2023).

Architectural design plays a crucial, multifaceted role in Sichuan's regional development, impacting its economic growth, urbanization, cultural identity, and environmental sustainability. The architecture industry is a vital part of Sichuan's economy, generating employment and contributing significantly to the GDP through various infrastructure, residential, and commercial projects. As urbanization continues, architectural design is essential for planning and constructing new, high-quality urban spaces, with a strong emphasis on innovative and sustainable design as outlined in the province's "14th Five-Year Plan." This includes incorporating eco-friendly materials, energy-efficient systems, and green spaces, aligning with environmental goals and improving residents' quality of life (Lin & Yang, 2023). Furthermore, architectural design helps preserve Sichuan's rich cultural heritage by integrating historical and cultural elements into new buildings. The industry is also embracing advanced technologies like Building Information Modeling (BIM) and smart building systems to enhance efficiency and reduce environmental impact (Xu et al., 2024).

Vocational learning is indispensable for the architectural design industry, equipping professionals with the necessary skills and practical experience. Vocational programs provide hands-on training in building materials, construction techniques, and architectural software, often developed in collaboration with industry professionals to ensure curriculum relevance (Wang et al., 2021; Li & Zhang, 2023). This type of learning is vital for developing a skilled workforce that can adapt to new technologies, sustainable practices (like green building), and innovative construction methods, thereby contributing to regional economic growth (McGrath et al., 2023). By providing skilled labor for construction and design firms, vocational learning attracts investment and stimulates job creation. It also fosters a culture of lifelong learning, allowing professionals to continuously update their skills as the industry evolves (Billett, 2020; Fong & Lim, 2020; Phakamach et al., 2023c; Wang et al., 2024). Moreover, vocational institutions often engage in research and development, advancing architectural design practices and contributing to social development by designing accessible and community-focused spaces. In essence, vocational learning is critical for cultivating a skilled workforce, driving innovation, and enhancing the economic and social well-being of communities in Sichuan's evolving built environment (Wang & Chen, 2021; Zhao & Li, 2024).

Digital advancements have revolutionized education, moving towards flexible, learner-centered models. Learning Management Systems (LMS) are central to this shift, serving as sophisticated platforms for administering, tracking, and delivering educational content. Evolving since the 1960s, modern LMSs offer features like personalized pathways, interactive content, and robust analytics, greatly facilitating distance and blended learning by providing accessible, engaging experiences (Adnan & Anwar, 2020; Anjuman & Islam, 2022). Successful LMS implementation depends on intuitive interfaces, seamless integration, and reliable support. To adequately prepare students for the evolving construction industry, vocational learning must significantly adapt to meet new demands for technical skills, innovation, and sustainability. Traditional curricula often fall short, leaving graduates unprepared

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for modern challenges. Students require hands-on exposure to cutting-edge technologies like Building Information Modeling (BIM), Virtual Reality (VR), Augmented Reality (AR), and Artificial Intelligence (AI), which are increasingly critical in industry recruitment (Bilal et al., 2025). Beyond technology, there's a pressing need to integrate sustainable design principles into education. This means fostering an interdisciplinary understanding of environmental, social, and economic sustainability, ensuring students grasp concepts like optimizing material use and improving energy efficiency in architectural projects. Bridging the gap between classroom theory and real-world practice is essential, necessitating a more practical, project-based learning approach that reflects industry realities (Gao et al., 2024; Cedefop, 2025).

Furthermore, enhancing vocational learning requires stronger collaboration between educational institutions and the construction industry. This partnership is vital for continually updating curricula to align with market needs, especially in areas like green and smart buildings. Crucial steps include improving practical training, such as internships, and optimizing project management courses with more industry realism. Current educational systems often struggle with limited practical resources, single-discipline curricula, and theory-focused assessment. Vocational colleges must prioritize developing students' interdisciplinary cooperation and a lifelong learning mindset so graduates can adapt to new technologies. By strengthening industry ties and jointly creating talent training plans, schools can ensure students master essential skills, thus enhancing their competitiveness and contributing to the construction industry.

Objectives

1) To study the vocational learning management of the architectural design major based on industrial demand in Sichuan province of China.

2) To create the model of vocational learning management of the architectural design major based on industrial demand in Sichuan province of China.

3) To evaluate the model of vocational learning management of the architectural design major based on industrial demand in Sichuan province of China.

Literature review

Learning Management System

The rapid advancement of digital technologies has profoundly transformed educational methodologies, shifting from traditional, instructor-centric models to more dynamic, flexible, and learner-centered approaches. At the forefront of this evolution is the widespread adoption of Learning Management Systems (LMS). Fundamentally, an LMS is a sophisticated software application designed to administer, document, track, report, and deliver educational content and training programs. Its lineage can be traced back to early computerized systems in the 1960s, evolving significantly to now offer a comprehensive suite of features, including personalized learning pathways, interactive multimedia content delivery, automated assessment functionalities, and robust analytical tools for monitoring student progress and engagement (Watson & Watson, 2007). The increasing popularity of LMS platforms is largely attributed to their unparalleled capacity to facilitate distance and blended learning environments, providing learners with unprecedented flexibility in accessing educational resources regardless of geographical location or time constraints (Zhang et al., 2024). This accessibility not only enhances student engagement but also caters to diverse learning styles and paces, fostering a more inclusive and adaptive educational experience. However, the successful implementation and optimal utilization of an LMS are contingent upon several critical factors, including an intuitive user interface, seamless integration with other educational technologies and institutional systems, and reliable technical support. These aspects remain crucial areas of ongoing research and development within the field of educational technology, as institutions continuously strive to maximize the pedagogical benefits of their LMS investments (Adnan & Anwar, 2020; Phakamach et al., 2024).

The successful integration and utilization of an LMS within an educational institution is not merely the adoption of a new technology; it is a complex process encompassing several critical stages and considerations. Literature on LMS processes often highlights a journey from initial planning and

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selection to ongoing optimization and evaluation. The initial phase typically involves a thorough needs assessment, where institutions identify specific pedagogical, administrative, and technological requirements. This stage is crucial for selecting an LMS that aligns with the institution's educational philosophy, curriculum demands, and existing ICT infrastructure (Phakamach, 2023). Following selection, the implementation phase is characterized by technical setup, data migration, and the configuration of courses and user accounts. This stage often presents challenges related to system compatibility, data integrity, and the technical expertise of the implementation team (Soeykrathoke et al., 2025). Effective project management, clear communication, and a phased rollout strategy are frequently cited as crucial for mitigating risks during this period.

Beyond the technical deployment, the true success of an LMS hinges on its adoption and sustained use by both educators and learners. Literature indicates that factors influencing adoption include perceived usefulness, perceived ease of use, and the quality of technical support and training provided. Many studies emphasize the importance of comprehensive training programs for faculty and students, tailored to various levels of digital literacy, to overcome resistance to change and maximize system functionalities. The ongoing management and optimization phase involves continuous monitoring of LMS performance, gathering user feedback, and regularly updating content and features to meet evolving educational and industry demands. This iterative process of refinement ensures the LMS remains relevant and effective. Challenges at this stage can include ensuring consistent internet connectivity, addressing algorithmic bias in personalized learning pathways, and overcoming a lack of awareness or motivation among some users (Phakamach et al., 2023c). Ultimately, a well-managed LMS process contributes significantly to enhancing student engagement, improving learning outcomes, and fostering digital literacy across the academic community, positioning the institution to adapt to future educational landscapes (Zhang et al., 2024; Phakamach et al., 2025).

Learning Management System in Vocational Education

In the specialized domain of vocational education, and particularly within practical and collaborative disciplines such as architectural design, the strategic deployment of an LMS becomes even more indispensable. These systems serve as central repositories for vast amounts of discipline-specific educational resources, ranging from comprehensive tutorials on complex 3D modeling and CAD software to virtual field trips of significant architectural landmarks and historical sites. Contemporary LMS platforms are increasingly integrating cutting-edge immersive technologies like AR and VR modules (Pan et al., 2020). These features enable architectural students to virtually "walk through" their design concepts, identify potential structural or aesthetic flaws in a simulated environment, and receive real-time, interactive feedback, which is an invaluable component of the iterative design process (Phakamach et al., 2024). Beyond merely facilitating technical skill acquisition, an LMS can also cultivate a deeper appreciation for architectural history, theory, and cultural context through interactive case studies, collaborative design challenges that promote culturally sensitive solutions, and forums for peer critiques. For vocational colleges, an LMS is instrumental in bridging the gap between academic theory and the practical demands of the professional world. It allows for the seamless integration of contemporary industry trends, such as sustainable design principles, by offering dedicated modules on eco-friendly materials, energy-efficient building systems, and green building certifications. By centralizing resources, enabling interactive and collaborative learning experiences, fostering continuous skill development, and aligning closely with industry standards, an LMS empowers vocational institutions to equip future architectural designers with the precise competencies required to excel in a rapidly evolving, technologically driven, and sustainability-focused global industry (Alshmrany & Al-Samarraie, 2021; Shornaevna et al., 2021; Han et al., 2023; Phakamach et al., 2023c; Supiani et al., 2024).

In summary, the widespread adoption of LMS has revolutionized education. An LMS is a sophisticated software that manages and delivers educational content, facilitating flexible distance and blended learning. Its successful implementation requires careful planning, robust technical support, and comprehensive user training to enhance student engagement and improve learning outcomes.

Competency-Based Education in Vocational Education

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Competency-Based Education (CBE) finds a particularly natural and impactful application within the realm of vocational education. Unlike traditional academic models focused on credit hours, CBE in vocational settings explicitly prioritizes the demonstrated mastery of specific, practical skills and knowledge essential for a particular trade or profession. This pedagogical approach is fundamentally aligned with vocational education's core mission: to prepare individuals with job-ready competencies directly applicable in the workforce (Alshmrany & Al-Samarraie, 2021; Phakamach & Panjarattanakorn, 2023a).

The rationale for CBE's prominence in vocational education is deeply rooted in its ability to address the pervasive "skills mismatch" that often plagues the labor market. Vocational programs adopting CBE models meticulously define industry-aligned competencies, ensuring that the skills taught are precisely those demanded by employers. This close alignment guarantees that graduates possess the practical abilities necessary to perform specific job functions effectively from day one. For instance, in architectural design vocational programs, CBE would focus on demonstrable skills like using specific BIM software, drafting precise technical drawings, or applying sustainable design principles, rather than just theoretical knowledge (Pan et al., 2020).

The benefits of CBE in vocational contexts are significant. Firstly, it directly enhances graduate employability by producing individuals whose credentials signify proven capability, making them highly attractive to employers. Secondly, CBE's personalized learning pathways are especially beneficial in vocational training, where learners often come with diverse prior experiences or require varied amounts of practice to master a hands-on skill. This flexibility allows for self-paced progression, ensuring deep understanding and skill retention. Thirdly, the emphasis on frequent, authentic assessments—such as practical demonstrations, portfolio reviews, and project-based evaluations—provides direct evidence of a student's ability to perform real-world tasks, far exceeding the value of mere theoretical exams. This robust assessment framework is crucial for quality assurance in vocational outcomes (McGrath et al., 2023).

However, implementing CBE in vocational education is not without its challenges. The shift requires a significant paradigm change for vocational instructors, moving from a traditional teaching role to one of coaching and facilitating mastery. This often necessitates substantial professional development for faculty to acquire new pedagogical skills and maintain up-to-date industry expertise (Gao et al., 2024). Furthermore, designing and managing the complex assessment systems required to evaluate nuanced practical competencies can be resource-intensive. Despite these hurdles, the inherent compatibility of CBE with the practical, outcomes-driven nature of vocational education positions it as a critical model for developing a skilled and adaptable workforce.

The Integration of Vocation Education and Industry

The concept of integrating vocational education with industry is a cornerstone of modern workforce development, aiming to bridge the persistent gap between academic learning and real-world employment demands (Shen et al., 2023). This integration, often termed "Industry-Education Fusion" or "school-enterprise cooperation," is vital for ensuring vocational training's relevance, quality, and responsiveness to dynamic labor markets (Zhang, 2025).

The rationale for such integration is primarily driven by the imperative to address skill mismatches, which occur when the competencies of graduates do not align with industry needs (Liu, 2022). By collaborating directly with industries, vocational institutions can ensure that curricula are up-to-date and reflect the latest technologies and practices (Xie et al., 2022).

Various models of integration exist, ranging from deeply immersive work-integrated learning (WIL) and apprenticeships that provide hands-on experience in authentic workplace settings (Patrick et al., 2016) to joint curriculum development and the sharing of resources like specialized equipment and facilities. Some advanced models include dual-mentor systems and the establishment of "learning factories" or "industrial colleges" directly within or closely affiliated with companies (Billett, 2020).

The benefits of this integration are manifold: enhanced graduate employability, improved educational quality, access to cutting-edge industry resources, and the development of a direct talent pipeline for businesses. However, significant challenges persist, including fragmented collaboration mechanisms, misalignment between academic offerings and evolving industrial demands, and the need

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for enhanced multi-stakeholder resource integration. Overcoming these requires clear communication, shared commitment, and flexible policy frameworks to ensure that vocational education truly prepares individuals for the demands of the contemporary workforce (Gao et al., 2024; Wang et al., 2024).

In summary, the literature review for this study explores several key concepts crucial to modern vocational education, particularly within architectural design. It first defines an LMS as a sophisticated platform for delivering and managing educational content, emphasizing its evolution and benefits in facilitating distance and blended learning. The review highlights that successful LMS implementation depends on a careful process of needs assessment, technical setup, and continuous optimization, requiring comprehensive training for users. The article then focuses on the role of an LMS in vocational education, noting its importance in providing access to discipline-specific resources like 3D modeling tutorials and immersive technologies such as AR and VR. This integration is crucial for bridging the gap between academic theory and the practical demands of the professional world. Finally, the review discusses CBE as a model that prioritizes the demonstrated mastery of practical skills over traditional credit hours, directly addressing the “skills mismatch” in the labor market. It also emphasizes the importance of integrating vocational education with industry through collaborations like apprenticeships and joint curriculum development to ensure graduates are prepared for a dynamic workforce.

Conceptual Framework

Based on a review of relevant literature, documents, and research, the researcher designed the research methodology by establishing a conceptual framework to identify the results of this research, as shown in Figure 1.

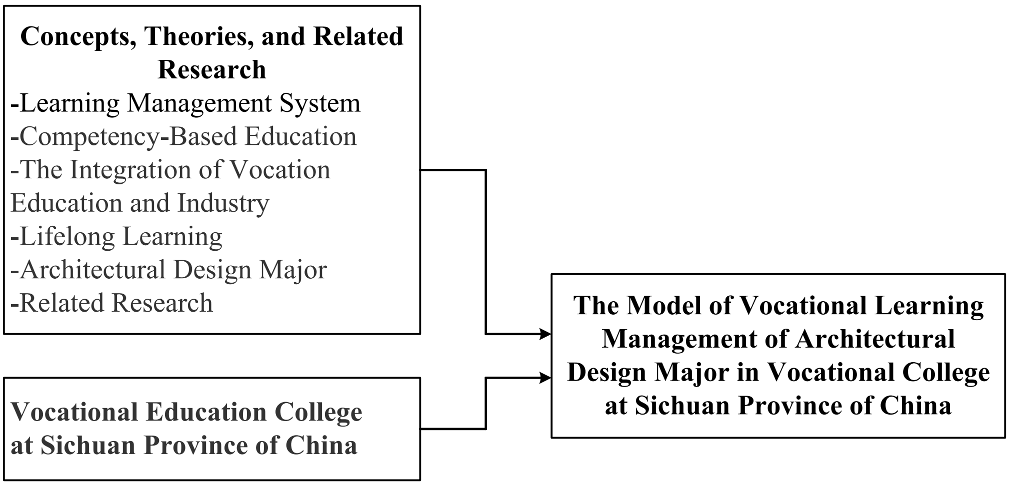

Figure 1: Research Conceptual Framework

Methodology

This study employs a mixed-methods design to comprehensively analyze vocational learning management in architectural design in Sichuan Province. The qualitative component, utilizing in-depth interviews and focus groups with students, educators, and industry professionals, will uncover challenges and opportunities within the architectural design education landscape. Complementing this, quantitative surveys will gather statistically analyzable data from diverse participants, providing empirical evidence of the vocational learning model’s effectiveness and its alignment with industry requirements. Details regarding the research methods are as follows:

Population and Sample

Population:

The study’s population included 1,024 students and 58 teachers from 12 educational institutions, along with 8 architectural design industry experts in Sichuan Province of China. This comprehensive population encompasses higher vocational colleges offering architectural design majors, students at

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various academic levels, faculty members, industry experts, and employers within the architectural design sector. The objective was to ensure a complete representation that reflects the diverse facets of vocational learning in architectural design.

Sample:

The samples for this research comprised 285 students and 52 teachers. The determination of the sample size was a critical step in the research design. For this study, the sample size was determined using the Krejcie & Morgan table, and stratified random sampling was employed from vocational colleges in Sichuan Province of China. Additionally, 8 architectural design industry experts were selected using a purposive sampling method based on specific qualifications:

(1) Having at least 10 years of experience in the architectural design industry; and/or

(2) Being an executive in the architectural design industry group with demonstrable achievements; and/or

(3) Possessing expertise in architectural design and having received national or international awards.

Research Phase Design

This study uses a mixed-methods design to thoroughly analyze the vocational learning management model for architectural design in Sichuan Province. This approach combines quantitative and qualitative methodologies to understand the educational landscape and its alignment with industry needs.

The qualitative element will involve in-depth interviews and focus groups with students, educators, and industry professionals. This will offer deep insights into the vocational learning experience, uncovering challenges and opportunities. Concurrently, quantitative approaches will use surveys distributed to diverse participants to gather statistically analyzable data, providing empirical evidence of the learning model's effectiveness.

Phase 1: Preparation

This initial phase defines research objectives, focusing on understanding and improving vocational learning management in architectural design in Sichuan. It includes a comprehensive literature review to identify relevant theories like CBE, Experiential Learning, and Workforce Development. A mixed-methods design will be developed, ensuring ethical considerations like informed consent and data confidentiality. Research instruments will undergo pilot testing for validity and reliability.

Phase 2: Data Collection

This phase concentrates on gathering a rich dataset. Field visits to vocational colleges and architectural design firms in Sichuan will facilitate distributing surveys to students, teachers, and industry professionals for quantitative data. In-depth interviews with administrators, industry leaders, and recent graduates will yield qualitative insights. Focus groups with students and recent graduates will provide additional qualitative feedback. Existing curricula, industry reports, and policy documents will be analyzed to assess alignment with industry standards. Throughout this phase, strict precautions will be taken to ensure data quality, security, and integrity through verification, adherence to regulations, regular inspections, and backups.

Phase 3: Data Analysis and Initial Findings

The final phase involves analyzing collected data for meaningful insights. Appropriate statistical methods (descriptive and inferential) will be used for quantitative data, while thematic analysis will be applied to qualitative data. The analysis will maintain objectivity, employing cross-validation techniques for reliability. Results will be presented using data visualization. A preliminary report will summarize findings, including key insights and initial recommendations, evaluating the current model's strengths and weaknesses to suggest improvements for better alignment between educational programs and industry needs.

Research Instruments

1) Questionnaire Survey

To quantify the effectiveness of the vocational learning model for architectural design, we'll design a questionnaire survey. This survey will gather data on architectural design students' skills, their

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employment status, and the industry's demand for talent. Questionnaires will be distributed to students, teachers, industry experts, and employers using random or stratified sampling. Statistical software will analyze this data, employing correlation and regression analyses to determine the relationship between the vocational learning model and industry needs. A new vocational learning model will be constructed based on survey findings and integrated with multiple assessment aspects to gauge its efficacy. This includes evaluating graduates' employment rate, the relevance of their skills to industry needs, and their workplace adaptability. We'll also incorporate employer feedback to ensure course content aligns with market demands and track students' long-term career development to assess the model's sustainable impact. Establishing a robust assessment framework will allow for continuous improvement, benefiting both students and the economy.

To ensure the quality of the questionnaire, its structural validity, content validity, and language appropriateness were assessed by three research instrument experts. Items with an Index of Consistency (IOC) of .5 or higher were selected, resulting in IOC values ranging from .59-1.0, with an overall IOC of .884. The questionnaire was then pilot-tested with 30 students and teachers not included in the main sample. Cronbach's Alpha Coefficient was used to determine reliability, and Item Total Correlation was used for item discrimination. The overall reliability of the questionnaire was .937.

2) Semi-structured Interview Guide

Interviews will be semi-structured, allowing for flexible conversations that cover essential topics like educational mode, course content, practical teaching aspects, and employment guidance. Discussions will delve into the strategies and philosophies of architectural design education, the alignment of content with industry trends and technology, the effectiveness of practical training, and career development support. By interviewing a diverse group of stakeholders, this research will create a comprehensive picture of the vocational learning management model in architectural design, guiding educational reforms and fostering closer industry alignment.

The research instruments included a 5-point Likert-scale questionnaire. The scoring criteria were: "Highest" (5 points), "High" (4 points), "Moderate" (3 points), "Low" (2 points), and "Lowest" (1 point).

3) Focus Group Discussion Guides

Focus group discussions serve to confirm the information derived from questionnaires and interviews, in alignment with the specific research questions.

Data Collection

Data Acquisition Steps

1) Determine the data requirements: According to the research purpose and research content, specify the type and amount of data to be collected.

2) Design data collection tools: According to data requirements, design questionnaires and an interview outline.

3) Determine the object of data collection: According to the research content, determine the object of data collection, including architectural design vocational learning institutions, architectural design enterprises, vocational learning teachers, architectural design vocational learning students, etc.

4) Data collection and implementation: collect data through field research, questionnaire survey, interview, etc.

5) Data collation and analysis: collate, clean, and analyze the collected data to ensure the accuracy and integrity of the data.

6) Write the data collection report: summarize the process, method, and results of data collection to provide a basis for subsequent research.

Precautions During Data Acquisition

1) Ensure data quality: ensure that the collected data is true, reliable, and complete, and avoid the research results being affected by data quality problems.

2) Protect data security: abide by relevant laws and regulations, and protect the privacy and information security of data collection objects.

3) Ensure data representativeness: Expand the scope of data collection and improve the representativeness and universality of data.

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4) Regular inspection of the data: In the process of data collection, check the integrity and quality of the data regularly, and correct the problems found in time.

5) Data backup: Backup of the collected data to prevent data loss.

Through standardized data collection procedures, we can ensure the quality of research data and provide reliable data support for subsequent studies and analysis.

Data Processing and Analysis

1) Ensure the accuracy of data analysis: Adopt correct statistical methods and analysis tools to ensure the accuracy of the analysis results.

2) Choose the appropriate analysis method: choose the appropriate analysis method according to the research purpose and data type. The specific methodology comprises four key components: Descriptive statistics analysis to characterize sample demographics, including gender, grade level, and course satisfaction. Correlation analysis to evaluate relationships between curriculum content and student satisfaction, as well as internship experiences and career development support. Analysis of variance (ANOVA) to compare differences in teaching satisfaction and career development assistance among students with varying academic years and internship backgrounds. Regression analysis to assess the impact of curriculum design, instructional methods, and internship experience on overall student satisfaction.

3) Keep objective and neutral: In the process of data analysis, keep objective and neutral and avoid subjective bias.

4) Cross-validation: Cross-verify the analysis results to improve the reliability of the analysis.

5) Data visualization: Use charts, graphics, and other visualization methods to visually display the analysis results.

6) Write a data analysis report: summarize the process, methods, and results of data analysis, and provide a basis for subsequent research.

Through standardized data processing and analysis, the accuracy and validity of the research results can be ensured to provide strong support for the development of vocational learning in architectural design in Sichuan Province of China.

Results

Based on the research study, the findings and data analysis, according to the research objectives, are presented as follows:

1. The Results of Studying the Vocational Learning Management of the Architectural Design Major Based on Industrial Demand at Sichuan Province of China

This study investigated the mental health status of vocational college students in Zhengzhou, Henan. Vocational architectural design education in Sichuan Province is gaining attention due to industry demands. This analysis will map its current landscape, examining the number and distribution of institutions, along with their disciplinary strengths, to understand its unique development and inform future improvements.

1.1 Educational Institutions in Sichuan's Architectural Design Vocational Education

Sichuan Province saw a 14.9% increase in higher vocational colleges from 2019 to 2024, growing from 74 to 85. Many institutions, including Sichuan Architectural Vocational and Technical College (SAVTC), offer diverse architectural design majors, continuously optimizing curricula to meet industry demands and cultivate skilled professionals for the construction sector. SAVTC, a national leader, provides comprehensive programs from core design to specialized fields like interior and garden design. Other colleges, like Nanchong Vocational and Technical College and Sichuan Vocational College of Science and Technology, also emphasize practical skills and theoretical foundations. Chengdu's Art Vocational University blends art and design, while Southwest University of Finance and Economics Tianfu College has pioneered virtual simulation projects for industry-education integration.

The geographical distribution of these institutions is uneven, heavily concentrated in Chengdu. This concentration stems from Chengdu's strong economy, proactive government policies, high demand for skilled professionals, and established educational history. Other regions have fewer institutions due to comparatively slower economic development and lower demand for architectural

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design professionals. These factors highlight a disparity in educational resources and vocational training opportunities across Sichuan Province of China.

1.2 Discipline and Quality in Sichuan's Architectural Vocational Education

Sichuan Province's architectural design vocational education is rapidly evolving, driven by advancements in discipline construction, curriculum, industry integration, and overall quality. Leading institutions, like SAVTC, spearhead this development. SAVTC offers over 60 majors, spanning traditional design to cutting-edge fields like intelligent construction and prefabricated building engineering. They actively innovate curriculum by integrating new technologies, achieving 100% integration into standards, and developing national online courses. Other colleges, like Chengdu Jincheng College and Sichuan University's School of Architecture, also employ unique models, incorporating concepts like "new infrastructure" and interdisciplinary integration.

Industry-education integration is a key focus, with SAVTC showcasing remarkable achievements in national teaching awards and modern apprenticeship pilot projects. They've established national-level vocational education groups and industrial colleges, reflecting deep collaboration. The Sichuan Provincial Department of Education strongly supports these efforts with policy incentives and promotion of productive training bases.

In terms of education quality, SAVTC has built a robust professional group system, developed numerous national and provincial "14th Five-Year Plan" textbooks, and established national "double-teacher" training bases, signifying strong faculty development. The provincial education department further enhances quality through curriculum optimization, innovation, and digital resource development.

Vocational institutions in Sichuan are categorized into key vocational colleges and ordinary vocational colleges. Key colleges, like SAVTC, possess strong resources, extensive industry integration (e.g., "1+1+1+N" model), and produce highly employable graduates. Ordinary colleges, while providing foundational training, focus on serving local economic needs with flexible curriculum settings. This comprehensive approach ensures the cultivation of high-quality technical talent for Sichuan's construction industry.

1.3 Characteristics of Architectural Design Vocational Training in Sichuan

Sichuan Province's architectural design vocational education focuses on meeting the rapidly growing industry demand for skilled professionals. This involves a critical examination of teaching staff, training objectives, and curriculum settings.

Teaching Staff

A high-quality teaching staff is crucial. Analysis of professional titles (e.g., professors, associate professors, lecturers) and educational backgrounds (e.g., Master's, PhD) across 12 vocational colleges reveals varying compositions. While professors are generally few (average 4.5%), lecturers are numerous (average 65%). Notably, dual-role teachers, who combine theoretical teaching with practical industry experience, form a significant portion (average 50%), particularly strong at Nanchong Vocational and Technical College (85.11%) and Tianfu College (83.33%). These dual-role teachers are vital for providing practical content. However, the relatively low proportion of professors and associate professors indicates a need for continued faculty development to enhance academic and teaching levels. All colleges prioritize teachers with master's degrees or above, ensuring a solid academic foundation, and many also emphasize practical experience through industry cooperation.

Training Objectives

Vocational colleges in Sichuan share common goals: cultivating "high-quality technical talents" with strong practical skills, professional ethics, and comprehensive development (moral, intellectual, physical, aesthetic). They aim for graduates to master architectural design theories, construction drawing, and project management, preparing them for roles in design, construction, and real estate. Emphasis is placed on practical experience and the pursuit of vocational qualification certificates (e.g., BIM).

However, challenges include the difficulty of the curriculum, which requires a broad scientific and cultural foundation. As junior college graduates, they may face disadvantages in job competition, needing more practical experience and certifications. The industry also demands resilience due to long

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hours and revisions. Entry-level salaries are modest (around 2,000-4,500 RMB). While objectives are broadly similar, institutions differ in their specific focus (e.g., tourism-related design, international vision, or specific technologies), offering students diverse choices based on their interests and career plans.

Curriculum Status

Architectural design curricula typically comprise six categories: professional basic courses, professional core courses, professional development courses, practical training courses, public basic courses, and elective courses. Professional basic courses, such as architectural art foundation, drawing, CAD, and performance techniques, establish theoretical foundations and essential skills for students. The balance and relevance of these course categories are continuously assessed to meet industry needs and ensure graduates possess up-to-date skills.

1.4 Alignment Between Industry Demand and Educational Supply

Surveys of Sichuan's construction industry reveal a growing demand for architectural design talent proficient in BIM technology, green building design, innovation, and practical skills due to digital and green transformations. While vocational institutions are adapting curricula, educational supply still lags behind industry demand. Deficiencies exist in integrating emerging technologies, allocating practical resources, and deepening industry-enterprise cooperation. Consequently, graduates often require longer adaptation periods to meet employer expectations.

1.5 Educational Quality and Student Employment Competitiveness

Sichuan's architectural design vocational education quality varies, with leading institutions excelling in innovation and practical training, while others face resource shortages. Graduates generally have high employment rates, but competitiveness differs. Students with more practical experience, emerging tech skills, and strong innovation capabilities demonstrate better job adaptability and career advancement.

In summary, the vocational learning model for architectural design in Sichuan Province has shown significant progress in educational infrastructure, curriculum development, and industry integration. However, challenges persist in more closely aligning educational content with industry demands, particularly concerning emerging technologies and practical skills. Furthermore, the uneven distribution of educational resources and varying institutional educational quality highlight the need for future optimization and resource allocation. Therefore, future efforts should focus on strengthening industry-education collaboration, updating curriculum content to reflect industry trends, and enhancing practical teaching resources to improve the overall quality and effectiveness of vocational architectural design education.

2. The Results of Creating the Model of Vocational Learning Management of the Architectural Design Major Based on Industrial Demand in Sichuan Province of China

The vocational learning management model for architectural design in Sichuan Province is evolving beyond traditional theoretical instruction to prioritize the cultivation of practical skills and comprehensive student development. This multi-dimensional approach aims to balance theory and practice, equipping students with in-depth industry knowledge and professional abilities to thrive in their future careers, thereby supplying the architectural design industry with highly skilled talent.

2.1 Integration of Production and Education & Practical Teaching

The Sichuan provincial government actively promotes the establishment of public practice centers that serve multiple functions: practical teaching, social training, skills competitions, intensive training, and real production/technical services. These centers provide invaluable internship and practical opportunities for students and support enterprise employee training, product piloting, and technology R&D, acting as a vital bridge between academia and industry.

Furthermore, Sichuan encourages vocational schools to collaborate closely with enterprises through "factory-in-school" and "school-in-factory" models. This innovative partnership allows students to gain real-world experience, enhancing their practical skills and professional quality. It also directly addresses industry needs for technical talent, ensuring a seamless transition from education to employment. This collaboration facilitates joint development of new teaching resources and practical programs, aligning curriculum with market demands.

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2.2 Innovative Teaching Methods in Vocational Education

Sichuan Province is actively exploring and practicing innovative education models. The Sichuan Vocational Education Development Research Center, leveraging university expertise, focuses on policy research, theoretical discussion, and practical application in vocational education. It collaborates with research institutes and enterprises to establish integrated science and education colleges, exploring new talent training modes through cross-border resource integration. This model emphasizes not only professional skills but also innovative thinking and comprehensive quality, providing students access to cutting-edge technology and practical project participation, fostering future industry leaders.

The province has also made significant strides in applying digital teaching methods in architectural design vocational education. This includes extensive use of intelligent education platforms, digital campus construction, personalized learning paths, interactive communities, and digital teaching resource databases. These advancements, exemplified by Chengdu Institute of Industrial Vocational and Technology's digital management system, optimize user experience, enhance data insights, and improve management efficiency. Digital campuses facilitate resource sharing, provide real-time monitoring for security, and allow for big data and AI-driven personalized education, transforming traditional learning into a more convenient, efficient, and safe environment.

2.3 Industry Demand-Oriented Vocational Education

Sichuan Province is proactively integrating vocational and general education to meet diverse talent cultivation goals. At the high school level, characteristic schools and comprehensive high schools are being developed, promoting cooperation between vocational and general schools for course selection and credit recognition. Vocational schools are also engaging with primary and secondary schools to offer career enlightenment and vocational experience education (e.g., architectural model making, VR experiences), leveraging practical training bases.

At the undergraduate level, a progressive cultivation project is underway, promoting the upgrading of qualified higher vocational schools to undergraduate vocational schools. This initiative aims to elevate vocational education quality and cultivate higher-level technical talent. Applied undergraduate schools are also collaborating with "Double High Plan" units and leading enterprises to offer undergraduate-level vocational education, primarily for secondary vocational graduates, providing both further education opportunities and talent for local economic development.

Professional construction in architectural design vocational education is closely linked to regional development and student needs. Measures include strengthening classification validity and adjusting based on industrial demands. Institutions like SAVTC have added emerging majors (e.g., intelligent construction) and removed outdated ones. The spatial layout of colleges is optimized to align with regional industrial economic belts, supporting key areas like the Chengdu Metropolitan Area. Vocational colleges are encouraged to build two or three key professional groups to enhance quality and ensure alignment with market demand, producing high-quality talent for intelligent construction and industrialization.

2.4 Course Content Optimization in Architectural Design Vocational Education

Sichuan Province is committed to promoting first-class courses in architectural design education through professional exchange meetings and university collaborations. The "Sichuan Design Professional First-Class Curriculum Construction Exchange Meeting" is an example, aimed at sharing best practices and improving design education quality.

Curriculum systems are being optimized for professional relevance. SAVTC, for instance, has designed a curriculum aligned with the Architectural Information Model (BIM) vocational skill level certificate examination, using real projects as teaching cases to achieve "1 + X" certification goals. Chengdu Art Vocational University offers a comprehensive curriculum from basic drawing to advanced design.

Practical teaching is vital. Sichuan Polytechnic of Architecture and Technology boasts national training bases and specialized rooms (e.g., BIM, 3D printing). Sichuan University's School of Architecture emphasizes practical links like art practice, design institute internships, and graduation design to ensure graduates possess solid theoretical knowledge and rich practical experience.

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Teaching reform and resource construction involve vigorously promoting information technology in vocational education. This includes building vocational education information benchmark schools that integrate ICT deeply into teaching, management, and learning, significantly enhancing educational quality and efficiency.

From the research, it can be demonstrated that the model of vocational learning management of the architectural design major in the vocational college in Sichuan Province of China, as shown in Figure 2.

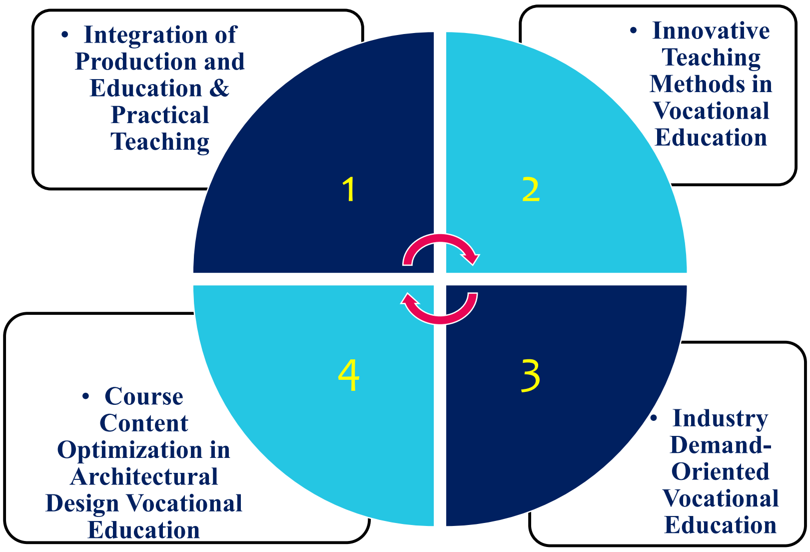

Figure 2: The Model of Vocational Learning Management of the Architectural Design Major in the Vocational College at Sichuan Province of China

3. The Results of Evaluating the Model of Vocational Learning Management of the Architectural Design Major Based on Industrial Demand in Sichuan Province of China

To comprehensively assess the effectiveness and adaptability of Sichuan Province's vocational learning model for architectural design, this evaluation focuses on how well the current educational framework aligns with evolving industry demands. The goal is to identify strengths and weaknesses, proposing targeted improvements to enhance overall vocational education quality. The assessment covers the fit between educational outcomes and industry needs, the innovation and adaptability of education models, the availability and effectiveness of educational resources and support systems, and the sustainability and future development potential of these models.

3.1 Evaluation Results of the Vocational Learning Model

An expert panel of eight evaluated the model across four key aspects: Utility, Feasibility, Propriety, and Accuracy. The evaluation results consistently met or exceeded the 70% threshold, indicating strong validation across all areas.

Integration of Production and Education & Practical Teaching: All sub-components (Public Practice Centers, Industry-Education Integration, School-Enterprise Cooperation, Talent Cultivation, and Practical Teaching) scored highly, with many achieving 100% in all categories. This highlights the model's perceived effectiveness in bridging the gap between academia and industry.

Innovative Teaching Methods in Vocational Education: Areas like Innovative Education Models, Digital Teaching Methods, Intelligent Education Platforms, and Digital Campus Construction all received 100% approval across all four evaluation criteria. This signifies a strong endorsement of the technological and methodological innovations being implemented.

Industry Demand-Oriented Vocational Education: Components such as Talent Demand and Vocational Education Integration, Vocational and General Education Integration, and Industry-

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Demand-Oriented Professional Construction also achieved high scores, with several reaching 100%. This indicates the model is well-regarded for its responsiveness to industry needs.

Course Content Optimization in Architectural Design Vocational Education: Professional and Course System Optimization, Practical Teaching, Teaching Reform and Resource Construction, First-Class Curriculum Construction, and Information Construction all received strong positive feedback, frequently scoring 100%. This underscores the perceived quality and relevance of the curriculum.

Expert Interview Insights

In-depth interviews with the eight industry experts further illuminated crucial aspects of the vocational learning model. Experts consistently identified four main areas of importance:

SIDE1: Fit Between Educational Outcomes and Industry Needs (100% importance): All experts agreed on the critical importance of aligning what students learn with what the industry requires.

SIDE2: Innovation and Adaptability of Education Models (100% importance): All experts emphasized the necessity for educational models to be dynamic and responsive to change.

SIDE3: Education Resources and Support Systems (87.5% importance): Seven out of eight experts highlighted the significance of adequate resources and support.

SIDE4: Sustainability and Future Development of Education Models (87.5% importance): Seven out of eight experts recognized the importance of the long-term viability and evolution of these models.

Detailed feedback from the experts also provided specific recommendations for improvement as follows:

1) Strengthening alignment of industry standards (8 experts): A universal agreement on the need for closer ties to industry benchmarks.

2) Adding actual project case analysis (7 experts): Emphasizing real-world application in the curriculum.

3) Deepening practical teaching (8 experts): A clear call for more hands-on experience.

4) Improving teachers' practical ability (8 experts): Highlighting the need for faculty with stronger industry experience.

5) Deepening the school-enterprise cooperation mechanism (8 experts): Recognizing the foundational role of partnerships.

6) Optimizing course content (7 experts): Ensuring curriculum remains relevant and up-to-date.

7) Strengthening the enterprise feedback mechanism (7 experts): Implementing a system for continuous improvement based on industry input.

8) Establishing a dynamic adjustment mechanism (8 experts): Creating a flexible system that can adapt to rapid changes.

9) Strengthening the cultivation of professional quality and ethics (7 experts): Focusing on soft skills and ethical considerations.

10) Strengthening international exchanges and cooperation (7 experts): Broadening perspectives and adopting global best practices.

11) Adding specific skills courses (7 experts): Addressing niche or emerging skill gaps.

12) Optimizing course connection (7 experts): Ensuring logical progression and coherence across the curriculum.

3.1 Fit Between Educational Outcomes and Industry Needs

Evaluating the alignment between educational outcomes and industry needs is crucial. This involves assessing if the skills and knowledge imparted to students are relevant and sufficient for their future roles.

1) Employment Rate and Professional Adaptability

Surveys of graduates from architectural design programs in Sichuan vocational colleges show a high employment rate. However, a notable issue is the professional adaptability of some graduates, who require a significant adjustment period in the workplace. This is largely due to a disconnect between theoretical knowledge gained in school and the practical skills demanded by actual work. For example, many graduates exhibit deficiencies in design software applications, construction drawing, and project site management, indicating a need to strengthen the cultivation of professional skills to meet industry demands.

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2) Matching of Skills and Knowledge

Research comparing industry needs with graduate skills revealed significant gaps. In technical skills, despite accelerated digital transformation and the widespread use of BIM, VR, and AR technologies, only 36% of graduates are proficient in BIM, and a mere 20% can apply VR/AR for design display. This stark contrast highlights that educational content lags behind industry needs in digital skill development. Regarding professional knowledge, particularly in green building design, only 35% of graduates possess a relatively deep understanding of concepts and technologies. Knowledge of building energy-saving and sustainable materials is also insufficient, reflecting a curriculum that hasn't adequately integrated emerging professional knowledge for the industry's green transformation.

3.2 Innovation and Adaptability of Education Models

The dynamic nature of the architectural design industry necessitates vocational education models that are not only current but also forward-looking and adaptable.

1) Curriculum Setting and Industry Dynamics

While some vocational colleges in Sichuan have begun to update their curricula by incorporating courses like BIM technology and prefabricated building design, the overall pace of curriculum updates lags behind industry development. Many colleges still prioritize traditional design theory, with insufficient emphasis on emerging fields like green building and intelligent construction. This curriculum imbalance results in graduates needing additional enterprise training to meet job requirements.

2) Innovation in Teaching Methods

Some colleges are experimenting with project-based learning and practical teaching to enhance student abilities. Successful examples include enterprise collaborations where students participate in entire project lifecycles. However, the widespread adoption of these innovative methods faces challenges. Teachers may lack proficiency in guiding project-based learning, and there's a shortage of practical teaching resources, including adequate bases and equipment. Outdated CAD software versions further hinder students' mastery of new technologies. Therefore, strengthening teacher training and investing in practical resources are crucial for the effective implementation of innovative teaching methods.

3.3 Education Resources and Support Systems

The effectiveness of any educational model relies heavily on its resources and support systems, including faculty, training facilities, and industry partnerships.

1) Faculty Team Building

The faculty team is a critical determinant of educational quality. While teachers generally have high academic qualifications, the proportion of "dual-qualified" teachers with extensive industry experience remains relatively low in Sichuan's architectural design vocational programs. This can lead to teaching content lacking practical application value. Additionally, teachers' practical teaching and project guidance abilities need improvement; many excel in theory but lack experience in guiding real-world projects. Strengthening faculty building by increasing the proportion of "dual-qualified" teachers and enhancing practical teaching abilities is essential.

2) Practical Teaching Resources

Investment in practical teaching bases has increased, with some colleges establishing internship facilities in collaboration with enterprises. However, overall practical teaching resources remain insufficient. Limitations include the number and scale of practical bases, which cannot meet student demand, and the outdated nature of equipment, which lags behind current industry technology (e.g., outdated CAD software). Increased investment in expanding and modernizing practical teaching resources is vital for enhancing students' practical abilities.

3.4 Sustainability and Future Development of Education Models

Ensuring the long-term relevance and effectiveness of vocational education models requires continuous evolution in response to technological advancements and shifting industry demands.

1) Policy Support and Industry Collaboration

Government policy support is crucial for sustainable development, with the Sichuan provincial government introducing various supportive policies and financial investments for vocational education

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and school-enterprise cooperation. However, implementation challenges remain, such as unclear detailed rules for some policies, hindering colleges in accessing funds or fostering partnerships. Furthermore, the depth and breadth of school-enterprise cooperation need further strengthening; many collaborations are superficial, lacking in-depth resource sharing and effective internship guidance. Clarifying policy implementation and establishing long-term, stable cooperative mechanisms are vital for sustainability.

2) Future Development Trend Forecast

The accelerating digital transformation and green sustainable development of the architectural design industry will shape future vocational education models, emphasizing:

(1) Deepening of digital education: Increased use of BIM, VR, and AR, with curricula focused on digital design skills. Teachers will adopt more digital methods like online courses and virtual labs, and schools will strengthen partnerships with digital enterprises for resource development and practical opportunities.

(2) Strengthening of green building design education: More courses on green building concepts, sustainable materials, and energy-saving technology, complemented by collaborations with green building enterprises for practical experience in actual projects.

(3) Integration of interdisciplinary education: Greater focus on combining engineering, management, and art to cultivate comprehensive skills and innovation, preparing students for the industry's demand for compound talents.

(4) Construction of lifelong learning systems: Establishing systems to provide graduates with continuous education and training opportunities to update their skills and knowledge in response to rapid technological and market changes.

In summary, while Sichuan's architectural vocational education model has achieved success in developing student professional skills and innovation, it faces issues. Future efforts must prioritize strengthening policy support, deepening school-enterprise cooperation, optimizing curriculum, enhancing teacher capabilities, and increasing practical teaching resources to improve the model's sustainability and adaptability, ultimately producing more high-quality professionals for the construction industry.

Discussion

Based on the results from the previous research, the significant findings could be discussed in line with the research objectives, as detailed below:

Comprehensive research into Sichuan's vocational education management model for architectural design has revealed critical challenges within the current system. While the model successfully imparts fundamental theoretical knowledge and basic skills, it struggles to equip students with the practical skills, innovative capabilities, and adaptability required for the industry's rapid technological advancements. This leads to extended adaptation periods for graduates entering the workforce, as they often fall short of enterprise technical requirements and job standards. Specifically, a significant gap exists between student proficiency in key areas like design software applications, project management, and sustainable design, and actual industry demands. This disparity stems from outdated teaching content that fails to keep pace with evolving technologies, materials, and processes. Furthermore, limited practical training resources restrict hands-on experience, hindering students' ability to apply theoretical knowledge. The shortage of "dual-qualified" teachers, possessing both academic and industry expertise, further exacerbates the issue by limiting students' exposure to current industry practices.

These underlying issues can be attributed to several factors. Firstly, unclear implementation details of vocational education policies create difficulties for schools and enterprises in collaboration, impacting facility updates and curriculum optimization due to complex funding procedures and superficial cooperative projects. Secondly, the rapid development of industry technology and shifting market demands pose a constant challenge for curriculum updates and innovative teaching methods. Traditional, lecture-based models are insufficient for cultivating the versatile talents demanded by the industry. Moreover, imperfect school-enterprise cooperation mechanisms lead to low enterprise

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enthusiasm for vocational education, limiting schools' access to crucial industry insights and practical resources. Lastly, an underdeveloped professional development system for teachers, coupled with a lack of incentives and training, impedes educators from timely knowledge updates and practical skill enhancement.

To enhance the quality of architectural design vocational education in Sichuan Province, a multi-faceted approach is essential, addressing policy support, curriculum reform, practical teaching resource construction, teacher team building, and school-enterprise cooperation. This requires joint efforts from educational departments, schools, and deep involvement from industry enterprises. By fostering closer school-enterprise mechanisms, optimizing the policy environment, strengthening teacher training and practical experience, and updating teaching content and methods, students' vocational abilities and employability can be significantly improved, better meeting the industry's demand for high-quality technical talent.

1. Implications for Vocational Education Policy

The research findings highlight the pivotal role of vocational education policy in shaping the effectiveness of architectural design education in Sichuan.

1) Policy Support and Resource Allocation

Effective policy must prioritize resource allocation to foster a high-quality educational environment. Increased government financial investment is crucial for upgrading practical training facilities with state-of-the-art equipment mirroring industry standards (e.g., latest CAD software, BIM tools, VR/AR equipment). This investment not only enhances learning but also boosts graduate employability.

Policies should also incentivize corporate participation through stable, long-term school-enterprise cooperation mechanisms. Such collaborations can involve joint curriculum development, internships, and real-world project involvement, benefiting both institutions (with industry expertise) and companies (by shaping the future workforce). Clear guidelines, incentives like tax breaks for participating companies, grants for curriculum development, and recognition programs are vital for fostering a supportive ecosystem and a culture of collaboration.

2) Industry-Demand-Oriented Education Reform

Vocational education policy must be centered on industry demands to drive continuous updates in educational content and methods, ensuring students are equipped with the most current knowledge. Policymakers should facilitate flexible and responsive curricula that can promptly incorporate emerging technologies (BIM, VR, AR) and sustainable design practices.

This requires educational institutions to establish regular feedback loops with industry partners through surveys, advisory boards, and conference participation to identify emerging trends and skill requirements. Teaching methods should evolve to emphasize experiential learning and problem-solving, such as project-based learning where students work on real architectural projects (e.g., designing sustainable buildings with BIM). Crucially, professional development for faculty is paramount, offering opportunities for industry internships, technology workshops, and collaboration with experts to integrate real-world applications into teaching. This forward-looking approach prepares students for future challenges and opportunities in the architectural design industry. These findings align with research by Zhang and Shao (2020), Alshmrany and Al-Samarraie (2021), Xie et al. (2022), Yan et al. (2023), and McGrath and Ramsarup (2024), which indicate that an effective and efficient vocational learning management model hinges on clear policy and robust support from stakeholders. It also requires collaboration with industry to propel the curriculum toward its aims and, crucially, to prioritize student skill development.

2. Impact on Industry and Employment

The vocational education model directly influences both the architectural design industry and student employment prospects.

1) Talent Cultivation and Industry Development Synergy

Optimizing the vocational education model can cultivate a larger pool of professionals with practical skills, an innovative spirit, and a commitment to sustainable development, thereby driving the industry's sustainable growth. Programs emphasizing hands-on training and real-world experience,

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such as project-based learning on actual architectural projects, bridge the academic-industry gap, enhancing practical skills and employability. Innovation is fostered through creative problem-solving and exposure to cutting-edge technologies. The growing demand for environmental sustainability necessitates incorporating courses on green building materials, energy-efficient design, and eco-friendly construction, producing environmentally responsible professionals. Collaboration through joint projects, internships, and mentorship programs provides valuable industry exposure and ensures a steady supply of well-prepared graduates.

2) Enhancing Student Employment Competitiveness

The vocational education model directly enhances students' employment competitiveness. Practical teaching is foundational, enabling students to apply theoretical knowledge in real scenarios, improving technical proficiency and problem-solving. Hands-on sessions in CAD, BIM, and model-making provide a competitive edge, alongside developing soft skills like teamwork and communication. School-enterprise collaboration through internships, co-op programs, and industry-sponsored projects offers invaluable work experience and networking opportunities, making graduates more attractive to employers. Regular curriculum updates reflecting the latest industry trends (VR, AR, sustainable design) ensure students are well-prepared. Furthermore, focusing on long-term career development through continuing education, professional development workshops, and certification courses fosters a culture of lifelong learning, ensuring graduates remain competitive in a dynamic job market.

These findings align with research by Liu (2022), Anjuman and Islam (2022), Shen et al. (2023), Phakamach et al. (2023c), Shen et al. (2023), and Gao et al. (2024), which indicate that an effective vocational education management model directly boosts students' job market competitiveness. Hands-on teaching is fundamental, allowing students to accurately apply theoretical knowledge in real scenarios. This effectively builds their technical proficiency and problem-solving abilities for the workplace.

3. Future Trends and Challenges

The architectural design industry's significant transformation, driven by digitalization and green development, necessitates an evolving vocational education system.

1) Integration of Digitalization and Green Building Education

The increasing adoption of digital tools like BIM, VR, and AR in architectural design demands their integration into vocational curricula. This involves not only teaching tool usage but also fostering understanding of their application across the entire project lifecycle. Simultaneously, the industry's focus on sustainability requires vocational education to emphasize green building design principles, sustainable materials, and energy-efficient technologies. Students must be proficient in both digital design skills and sustainable practices, balancing theoretical knowledge with practical experience through project-based learning, internships, and industry collaboration.

2) Lifelong Learning and the Connection to Vocational Education

The rapid pace of technological change and shifting market demands underscore the importance of lifelong learning. Vocational education must support this by establishing strong connections with lifelong learning systems. This includes providing continuous education and training opportunities for both students and working professionals through short courses, workshops, and online platforms focusing on emerging trends. Creating seamless transitions between initial vocational education and lifelong learning systems, via clear pathways and recognition mechanisms for further education, is crucial. Partnerships with professional organizations can provide networking and mentorship. By fostering a culture of continuous learning, vocational education helps professionals adapt to new technologies and market demands, contributing to the industry's resilience and innovation.

In summary, while Sichuan's architectural vocational education model has achieved successes, it faces challenges. Future efforts must prioritize strengthening policy support, deepening school-enterprise cooperation, optimizing curriculum, enhancing teacher capabilities, and increasing practical teaching resources to improve the model's sustainability and adaptability, ultimately producing more high-quality professionals for the construction industry.

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Knowledge Contribution

The vocational education model for architectural design in Sichuan Province is undergoing a significant transformation, aiming to directly enhance students' employment competitiveness. This evolution moves beyond traditional theoretical instruction to prioritize the cultivation of practical skills and comprehensive student development. A key component of this model is practical teaching, which serves as a crucial foundation, allowing students to accurately apply theoretical knowledge in real-world scenarios. This approach effectively develops their technical expertise and problem-solving skills, which are essential for efficient performance in the workplace.

The provincial government actively promotes the establishment of public practice centers that offer practical teaching, social training, skills competitions, and practical production services. Furthermore, close collaboration between vocational schools and enterprises through "factory-in-school" and "school-in-factory" models enables students to gain invaluable real-world experience, thereby enhancing their practical skills and professional readiness. This innovative partnership not only addresses industry needs for technical talent but also ensures a seamless transition from education to employment. Regular curriculum updates reflecting the latest industry trends, such as BIM, VR, AR, and sustainable design, are crucial to ensure graduates are well-prepared for modern challenges. While significant progress has been made in infrastructure and curriculum development, challenges remain in fully aligning educational content with the rapidly evolving demands of the industry, particularly concerning emerging technologies and practical skills. Future efforts should therefore focus on strengthening industry-education collaboration and enhancing practical teaching resources to optimize the overall quality and effectiveness of vocational architectural design education.

Recommendations

The researchers put forward two kinds of feedback as follows:

Recommendations for Applying Research Findings

1) Strengthen Industry-Education Collaboration for Curriculum Alignment and Practical Training: The research highlights that effective vocational learning management directly enhances students' employment competitiveness through practical teaching and real-world application. To leverage this, vocational colleges in Sichuan Province should formalize and deepen their partnerships with architectural design firms and construction companies. This includes establishing joint curriculum development committees to ensure that course content, particularly regarding emerging technologies like BIM, VR, AR, and sustainable design principles, is consistently updated and aligned with current industry demands. Furthermore, expand and diversify practical training opportunities such as internships, co-op programs, and industry-sponsored projects. These initiatives provide invaluable hands-on experience, allowing students to apply theoretical knowledge in authentic scenarios, thereby significantly improving their technical proficiency and problem-solving skills in the workplace. This direct engagement with industry will ensure graduates possess the precise competencies required to excel in a rapidly evolving job market.

2) Enhance Technology Integration and Digital Literacy through LMS: The study underscores the pivotal role of digital advancements and LMS in modern education. Vocational colleges should fully embrace and optimize their LMS platforms to deliver flexible, learner-centered experiences. This involves not only utilizing LMS for administering and tracking educational content but also integrating cutting-edge immersive technologies like AR and VR modules for architectural design. These features enable students to virtually "walk through" designs and receive interactive feedback, crucial for iterative design processes. Beyond technical skills, the LMS can foster a deeper appreciation for architectural history and cultural context through interactive case studies and collaborative design challenges. Ensuring intuitive interfaces, seamless integration with other educational technologies, and reliable technical support are critical for successful LMS implementation and adoption by both educators and learners, ultimately preparing students for a technologically driven industry.

3) Implement and Expand CBE with Robust Assessment: The research emphasizes that CBE is naturally impactful in vocational settings as it prioritizes the demonstrated mastery of specific, practical skills. Vocational colleges should systematically adopt and expand CBE models within their

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architectural design programs. This means meticulously defining industry-aligned competencies for each skill, ensuring that teaching and assessment focus on demonstrable abilities (e.g., using specific software, drafting technical drawings, applying sustainable design). Personalized learning pathways should be encouraged to accommodate diverse learning paces, and authentic assessments, such as practical demonstrations, portfolio reviews, and project-based evaluations, must be prioritized over traditional theoretical exams. This robust assessment framework provides direct evidence of a student's ability to perform real-world tasks, making graduates highly attractive to employers and addressing the persistent “skills mismatch” in the labor market.

Recommendations for Future Research

Future research should focus on the following areas:

1) Longitudinal Study on Graduate Employability and Career Progression: Future research should conduct a longitudinal study to track the employment outcomes, career progression, and long-term competitiveness of graduates from vocational architectural design programs that have implemented the proposed learning management model. This would involve collecting data on employment rates, salary levels, job satisfaction, and professional development trajectories over several years. Such a study would provide empirical evidence of the model’s sustained impact on graduates’ careers and offer insights into areas for continuous improvement.

2) Comparative Analysis of Different Industry-Education Collaboration Models: Given the importance of industry-education integration, future research could conduct a comparative analysis of various collaboration models (e.g., “factory-in-school,” dual-mentor systems, industry-sponsored projects) within architectural design vocational education. The study should evaluate the effectiveness of each model in terms of student skill development, industry relevance of the curriculum, and overall graduate employability. This would help identify best practices and inform policy decisions for optimizing partnerships between vocational colleges and the architectural industry.

3) Investigation into the Impact of Emerging Technologies on Curriculum Design and Teaching Methodologies: As the architectural industry rapidly adopts new technologies, future research should delve deeper into the specific impact of AI, VR, and AR on curriculum design and teaching methodologies within vocational architectural design programs. This research could explore how these technologies can be most effectively integrated into practical training, project-based learning, and assessment, and investigate the necessary professional development for educators to proficiently teach with these tools.

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