



Enhancing professional competency development: Construction and application of an AIGC-empowered TFS-SRIE model in coffee preparation course

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Abstract

With the global proliferation of digital technologies, generative artificial intelligence (AIGC) has been widely adopted in vocational education, offering new solutions to persistent instructional challenges in skills-based courses. Guided by competency-based education and connectivist learning theory, this study proposes the TFS-SRIE practical model for the secondary vocational Coffee Preparation course. The model is supported by three assurance dimensions—technical specifications, faculty capacity, and school–enterprise collaboration—and implemented through four pathways: scenario development, resource generation, instructional adaptation, and evaluation construction. Using the Coffee Preparation Course as an illustrative case, the paper details the model's implementation procedures and teaching strategies, and evaluates its effectiveness in enhancing learning motivation and interest, enabling personalized learning, deepening skills mastery, and fostering innovative competence. The findings suggest that the TFS-SRIE model provides a transferable and actionable framework for integrating AIGC into secondary vocational curricula, contributing practical insights for advancing digital transformation and professional competency development in vocational education.

Keywords:

AIGC
Coffee preparation course
Professional competency development
Secondary vocational education
TFS-SRIE practical model.

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Transparency: The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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1. Introduction

In the context of accelerated educational digitalization, vocational education is undergoing a profound transformation from traditional skills training toward data-driven, intelligent, and competency-oriented talent cultivation (Li & Wang, 2025; Yang, 2025). As a key pathway for strengthening the supply–demand alignment between education and industry, digital transformation not only reshapes teaching environments and learning resources, but also directly affects the quality of skill formation, workplace adaptability, and long-term employability of vocational students. However, compared with general education, vocational education faces more complex requirements for digital upgrading, as its curriculum must simultaneously respond to real production processes, enterprise standards, and authentic work tasks. Therefore, exploring feasible models for integrating digital technologies into skill-based curricula has become a crucial issue in the ongoing reform of vocational education. Against this backdrop, the deep integration of vocational skills courses and artificial intelligence is increasingly necessary. Generative Artificial Intelligence (AIGC), as a representative emerging technology in intelligent education, offers distinctive functional advantages for addressing persistent instructional constraints in vocational training (Oben, Hui, Bahtilla, & Quanguo, 2025). Its capabilities in content generation, intelligent scenario simulation, and precise data analysis align closely with the logic of “learning by doing” and the goals of competency development. In particular, AIGC makes it possible to create immersive and intelligent learning scenarios, generate diversified training resources, provide personalized learning support, enhance teachers’ instructional design and guidance capacity, and optimize the evaluation system toward process-based and evidence-informed assessment (Song & Luo, 2024; Yu, Tan, Liu, & Chen, 2024). These advantages offer practical technical support for the transition of vocational skills training from experience-based delivery to digital, job-oriented, and innovation-driven learning pathways.

The secondary vocational Coffee Preparation Course was selected in this study because it represents a typical skills course characterized by a high degree of integration between theory and practice, strong operational requirements, and close alignment with industry standards. The course aims to cultivate students’ vocational skills and job competitiveness through practical training, making it an ideal context for examining how AIGC can empower skill acquisition and workplace readiness. Nevertheless, in the process of digital transformation, the course currently faces multiple development challenges, including limited teaching scenarios, insufficient practical resources, inadequate personalized guidance, and a rigid evaluation system, which collectively reduce students’ learning engagement and hinder effective competency development (Chen, 2024). Moreover, regarding the mastery of industry-leading skills, the overall performance of secondary vocational students still falls short of the modern tourism service industry’s expectations for coffee-skilled talents, further highlighting the urgency of instructional innovation.

Based on these considerations, and guided by the requirements of industry–education integration and the principle of unifying knowledge and practice in vocational education (Zhou & Tan, 2025) this study proposes an innovative practical model for AIGC-empowered secondary vocational coffee education. Centered on the four critical teaching components—scenarios, resources, instruction, and evaluation—the model leverages AIGC technology as the core driving force to restructure and innovate the entire teaching process. To ensure effective implementation, a multidimensional support system is further established from the perspectives of technology, teachers, and school–enterprise collaboration, providing a transferable model reference for the digital reform of practical training courses in secondary vocational programs, particularly within high-star hotel operation and management.

2. Theoretical Framework

2.1. Competency-Based Education

As a systematic educational philosophy, competency-based education holds that the fundamental goal of education is to enable learners to acquire the comprehensive capabilities required to successfully perform job responsibilities in real work contexts, rather than merely transmitting knowledge or mechanically accumulating instructional hours (Chen, 2024). The core premise of competency-based education lies in the establishment of measurable occupational competency standards (De Vos, Baartman, Van der Vleuten, & De Bruijn, 2024). In the digital era, this philosophy has been endowed with new connotations, as the components of vocational competence are expanding from traditional operational skills and technical knowledge toward an integrated system encompassing digital literacy, information processing, innovative thinking, and complex problem-solving abilities (Li & Wu, 2025). Against this backdrop, the application of a “Assurance of TFS and pathways for SRIE” practice model—designed to dynamically respond to industrial transformation, precisely align with job requirements, and support personalized competency development—in the secondary vocational Coffee Preparation Course under the support of AIGC technology vividly demonstrates the value of the competency-based education paradigm.

The theory of competency-based education provides a comprehensive theoretical foundation for the construction of the AIGC-empowered TFS-SRIE Practical Model in secondary vocational curricula, offering both holistic safeguards and feasible implementation routes to ensure that the model remains aligned with industrial demands and educational principles, thereby enabling contextualized, personalized, and intelligent competency development.

2.2. Connectivist Learning Theory

Connectivist learning theory, proposed by Siemens (2005) is widely regarded as one of the most representative learning theories of the digital age (Scott, 2016). Its core premise holds that, in an information-rich era, learning is no longer a process of internal knowledge accumulation within the individual, but rather a capability realized through the creation, navigation, and sustained maintenance of networks of connections (Downes & Xiao, 2022).

The secondary vocational Coffee Preparation Course exhibits a hybrid curriculum profile that integrates theory and practice while closely aligning educational objectives with industry needs. Its curriculum structure encompasses both theoretical knowledge modules and hands-on skills training. This composite nature of the Curriculum dictates that instructional implementation must not only ensure students' comprehension and internalization of abstract theoretical concepts, but also facilitate the proficient mastery of operational skills, while dynamically aligning teaching content with evolving industry and job requirements (Wang & Qiu, 2021). At present, however, the delivery of secondary vocational coffee-making Curriculum faces multiple challenges, manifested in four key areas: first, rigid instructional scenarios that fail to stimulate student engagement; second, homogeneous training resources with limited alignment to industry positions; third, insufficient teaching capacity and instructional approaches that lag behind contemporary developments; and fourth, an incomplete assessment system that provides inadequate feedback on learning outcomes (Meng, Ma, & Wang, 2023; Olofsson, 2025). Accordingly, the introduction of generative artificial intelligence (AIGC) to empower the reform of the secondary vocational Coffee Preparation Course is not merely an additive deployment of technological tools, but rather a curriculum-level innovation grounded in connectivist learning theory. Within the "Assurance of TFS and pathways for SRIE" practice model, the resource generation pathway leverages AIGC to dynamically connect real-time industry data, professional knowledge graphs, and learners' personalized needs, thereby constructing a continuously evolving and self-updating resource network—an approach that closely aligns with the learning paradigm advocated by connectivism.

3. Constructing the AIGC-Empowered TFS-SRIE Practical Model for Secondary Vocational Courses

The TFS-SRIE Practical Model is an AIGC-empowered framework composed of four core driving pathways and three supporting assurances, proposed within the broader context of the digital transformation of vocational education to systematically address the structural challenges faced by secondary vocational programs in teaching resources, instructional scenarios, pedagogical models, and assessment practices.

3.1. The "Three Assurances" Safeguard and Consolidate AIGC-Empowered Teaching Outcomes

The "three assurances" constitute a support system for translating theory into practice, comprising technical specifications, Faculty capacity and competence, and School-enterprise collaboration. Together, they address the critical question of how generative artificial intelligence (AIGC) can continuously empower secondary vocational curricula. Technical specifications focus on ensuring the standardized and responsible application of AIGC in the Coffee Preparation Course by establishing robust technical specifications and quality assurance mechanisms. Through the development of interactive instructional resources that integrate multimodal content, AIGC's dynamic generation capabilities are leveraged to transform abstract principles of coffee science and sensory application into visualized 3D models and immersive animations, thereby strengthening students' concrete understanding. Teacher capacity serves as the foundational guarantee for the effective implementation of AIGC-Empowered instruction. Emphasis is placed on enhancing teachers' digital literacy and their ability to apply intelligent technologies by strengthening competencies in the basic operation of AIGC tools, the use of intelligent teaching platforms, and data analysis and learning diagnostics (Káplár-Kodácsy, Dorner, & Rónay, 2025). This process fosters the development of digitally competent and intelligence-oriented teaching teams in secondary vocational education, aligns faculty development with curricular evolution, and ensures the sustainable empowerment of Curriculum through technology. At the same time, deepening school-enterprise collaboration enables the construction of a dynamic system for updating industry-leading knowledge. Vocational institutions, in partnership with leading enterprises in the coffee industry, jointly establish AIGC-based teaching resource development centers that translate authentic workplace scenarios and the latest process standards into digital instructional cases. This approach ensures that teaching content remains synchronized with industry developments, while AIGC is used to track in real time technological innovations and evolving standards in the coffee sector, comprehensively advancing the intelligent development of AIGC-supported theoretical instruction.

3.2. The "Four Pathways" Drive the Integration of AIGC into Curriculum Teaching

The "four pathways" consist of the Scenario development pathway, the resource generation pathway, the instructional adaptation pathway, and the assessment optimization pathway, all of which operate at the level of instructional practice and are aimed at addressing how generative artificial intelligence (AIGC) can be effectively integrated into teaching. With respect to Scenario development, traditional theory-based instruction struggles to translate abstract knowledge into visualized forms, while practical training

components often fail to simulate the complexity and dynamic conditions of real workplace settings. This not only suppresses students' learning interest and exploratory motivation, but also creates a gap between their skill development and actual industry requirements. Leveraging its core capabilities in dynamic content generation and virtual scenario construction, AIGC technology provides a feasible technical pathway for addressing the aforementioned shortcomings. It facilitates the transformation of instructional scenarios from static and homogeneous formats to dynamic and complex environments, enabling deep integration between Curriculum content and teaching contexts and thereby enhancing instructional appeal and effectiveness. In terms of resource generation, AIGC's strengths in virtual creation, dynamic analysis, and intelligent collaboration make it possible to compensate for limitations in physical resources through virtual alternatives. Ultimately, this enables training resources to meet emerging job demands related to intelligent operations, flavor innovation, and new product development in the industry, more effectively addressing existing challenges in coffee training Curriculum. With respect to instructional adaptation, enhancing teachers' digital literacy and establishing teaching systems aligned with instructional activities can effectively resolve the tension between standardized pacing and individual learner differences inherent in traditional teaching. While ensuring the orderly implementation of instruction, this approach realizes personalized, demand-oriented talent development, significantly improving the precision and adaptability of Curriculum delivery. In terms of assessment optimization, as the final stage of the teaching process, this pathway integrates with other instructional components to establish a continuous improvement mechanism characterized by full-process data collection, multidimensional indicator evaluation, and industry-collaborative iteration. By leveraging AIGC's multimodal data collection and analytical capabilities, the assessment paradigm shifts from summative judgment to developmental empowerment, providing sustained data support for instructional improvement. Supported by the three safeguarding assurances, these four pathways jointly construct an intelligent learning system for secondary vocational professional Curriculum in which scenarios can be virtualized, resources dynamically generated, guidance personalized, and evaluation rendered more comprehensive.

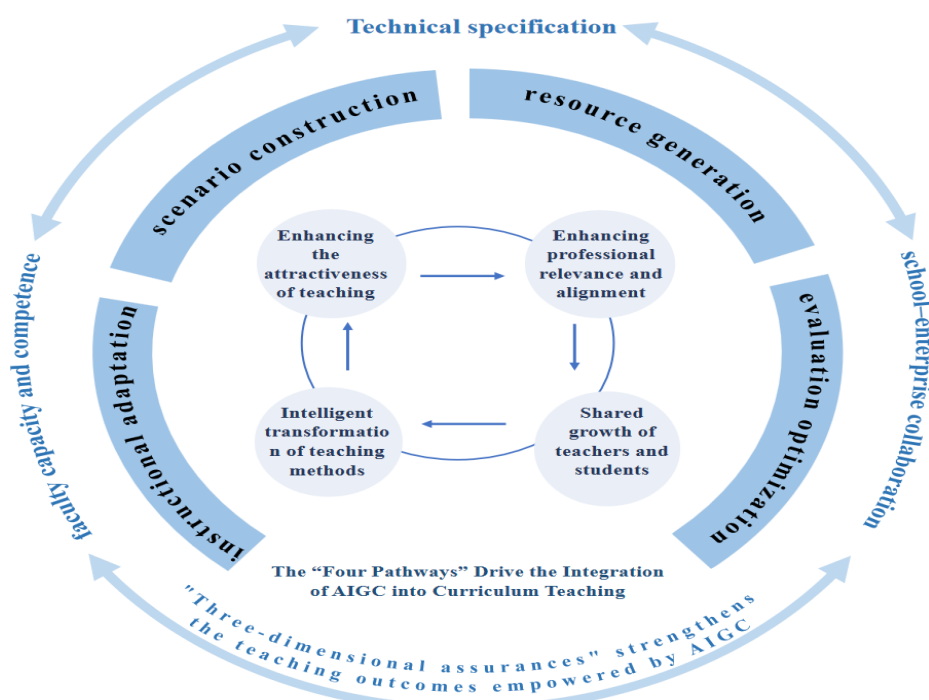


Figure 1. Structural diagram of the "assurance of TFS and pathways for SRIE" teaching model.

4. Application of the AIGC-Empowered TFS-SRIE Practical Model in the Coffee Preparation Course

The secondary vocational Coffee Preparation Course is a composite curriculum that integrates theory and practice while closely linking educational objectives with industry needs; drawing on the core chapter framework of the nationally planned vocational education textbook and the tourism industry skills training manual Coffee Skills, and implemented in accordance with Ministry of Education teaching standards, the Curriculum comprises five modules—coffee culture fundamentals, knowledge of raw materials and equipment, core production techniques, creative beverage development, and Coffee service and management—encompassing both theoretical components such as the historical evolution of coffee culture, analysis of raw material characteristics, and principles of coffee preparation, as well as practical components including basic brewing processes, flavored beverage development, and service workflows, a structure that requires

instruction to ensure students' understanding of abstract theoretical knowledge, mastery of operational skills, and the dynamic alignment of teaching content with evolving industry and job requirements.

4.1. Building a Virtual Coffee Aligned with Authentic Industry Tasks

As the core medium linking disciplinary knowledge with skill acquisition, instructional scenarios have become increasingly constrained by rigidity, emerging as a critical bottleneck in the quality of teaching in secondary vocational Coffee Preparation Course. By integrating AIGC with VR or AR technologies, multi-layered training environments that blend virtual and physical elements can be constructed. These environments not only present spatial layouts and design styles, but also use dynamic video to depict customer flow patterns across different time periods, customer profiles, and consumption behaviors. Within such highly realistic professional contexts, students deepen their understanding of market positioning theory by comparatively analyzing customer needs, purchasing power, and product preferences across varied scenarios, thereby establishing an authentic cognitive foundation for subsequent product creativity and design.

Taking the learning of the Coffee service and management module as an example, teachers can move beyond the limitations of traditional lecture-based delivery of theoretical knowledge by employing AIGC image generation tools to construct multi-layered professional scenarios. With the support of school-enterprise collaboration, vocational institutions establish strategic partnerships with leading coffee brands, chain enterprises, and technology service providers, through which industry partners assist by supplying core materials such as real store operational data, standard operating procedures, representative customer profiles, and seasonal product strategies. Based on these frontline industry data, precise scenario prompts can be input to rapidly generate visualized materials and construct a virtual Coffee encompassing functional zones such as ordering areas, production areas, and customer spaces. Within these digital environments, students can assume roles such as baristas and cashiers, immersively experiencing authentic business operations ranging from order taking to production and from service delivery to management. This approach helps students gain an in-depth understanding of real workplace tasks in coffee shops and appropriately apply textbook knowledge to contextualized scenarios, thereby facilitating the development and transfer of job-related competencies. In addition, AIGC can generate virtual customers with diverse needs and behaviors and simulate multitasking scenarios, effectively strengthening students' comprehensive abilities in time management, communication and coordination, and emergency response.

4.2. Constructing a Dynamic Coffee Resource Repository to Enrich the Theoretical Knowledge System

In the unit on coffee culture fundamentals, students often experience confusion and difficulty in knowledge absorption due to the strong theoretical nature of the content and the large volume of information that must be memorized. By leveraging AIGC's dynamic knowledge generation mechanisms, students can refine prompts to guide tools such as DeepSeek to produce analytical content across assurances including aroma layers, acidity intensity, and body variations, as well as intelligent pairing recommendations, thereby engaging in inquiry-based learning (Zhong, Lin, & Liu, 2026). This process not only expands the breadth and depth of learning resources but also cultivates students' information literacy and innovative thinking. At the same time, drawing on AIGC's creative generation capabilities, students can input prompts such as "themed creative coffee" or "flavored coffee production plans" to obtain comprehensive solutions that include flavor descriptions, formula ratios, and production processes (Song & Luo, 2024). These digital resources supplement Curriculum instruction and contribute to the formation of a training resource repository that integrates intelligent operations, flavor innovation, and new product development. The integration of technology and knowledge gradually enables students to shift from passively receiving static textbook content to actively exploring dynamic knowledge systems (Downes & Xiao, 2022). This transformation not only significantly reduces the cognitive load associated with theoretical learning and helps students build a clear conceptual framework of coffee knowledge, but also effectively fosters information literacy, systemic thinking, and scientifically grounded innovative practice through the interactive processes of resource generation and application.

4.3. Human-AI Collaborative Guidance to Optimize Skills Training

To address the challenge in traditional instruction whereby teachers' personalized guidance cannot effectively reach all students, the Curriculum introduces an AI coaching program integrated into mobile platforms. Through close collaboration with artificial intelligence technology enterprises, this program enables the joint development of specialized algorithmic models tailored to coffee skills training. While drawing on their professional expertise to provide hands-on instruction, teachers leverage the intelligent support of AI coaches to collaboratively deliver integrated theory-practice teaching.

The unit on core production techniques comprises two practical components: coffee extraction and latte art skills training. During espresso extraction practice, students can obtain precise improvement suggestions by inputting parameters such as extraction time, flow rate, and images of the finished product. In the latte art training segment, the system employs motion capture technology to analyze key parameters such as hand movement amplitude and pouring angle, providing visualized recommendations for improvement. This

mechanism of immediate and professional feedback enables large-scale personalized instruction and effectively accelerates the process of skill acquisition. Based on learning analytics data provided by the AI coach, teachers identify students' weaknesses during the learning process and conduct targeted explanations and demonstrations, thereby further enhancing instructional interaction and effectiveness. Through human-AI collaboration, classroom teaching efficiency is substantially improved.

4.4. Establishing an Intelligent Comprehensive Assessment System to Promote Students' Holistic Development

In the assessment of practical skills performance, AI systems employ image recognition technologies to quantitatively analyze assurances such as pattern symmetry, line clarity, and creativity in latte art works, providing data-driven support for teachers' evaluations. In the evaluation of creative proposals, teachers utilize AIGC tools to conduct multidimensional analyses of students' beverage design plans, examining indicators such as the rationality of flavor descriptions, alignment with target customer segments, and feasibility of marketing strategies, and generating detailed assessment reports. This comprehensive assessment approach attends to both operational skills and innovative thinking, thereby advancing teaching toward the cultivation of integrated vocational competencies (Li & Wu, 2025).

By leveraging AIGC's capabilities in data mining and learning analytics, the collected process-oriented data are deeply modeled to automatically generate personalized learning diagnostic reports that accurately identify students' skill gaps and developmental potential, while providing targeted improvement suggestions and learning resource recommendations for each learner. This approach enables the creation of an intelligent teaching support system that integrates instruction, management, and assessment, allowing teachers to conveniently deploy AIGC technologies for differentiated group guidance, monitor students' skill acquisition progress in real time through learning analytics modules, and, based on learning reports generated by the intelligent assessment system, shift from homogeneous, collective instruction to data-driven personalized intervention and coaching. Consequently, teaching assessment evolves from a single-purpose tool for outcome judgment into an intelligent engine that continuously optimizes the teaching process and precisely promotes student development, significantly enhancing the scientific rigor and educational value of evaluation and providing intelligent support for systematically improving instructional precision and talent cultivation quality, thereby transforming traditional monolithic teaching models.

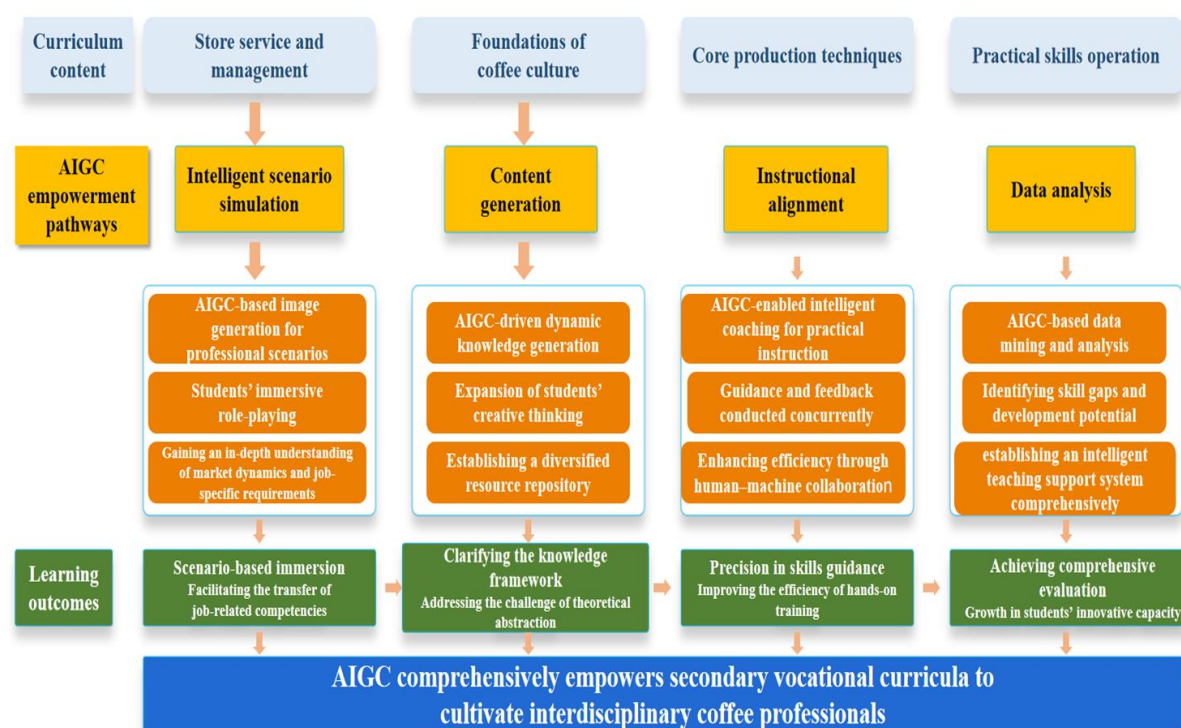


Figure 2. Application of the TFS-SRIE practical model in the coffee preparation course.

5. Conclusion and Future Prospects

At the present stage, vocational education stands at a strategic intersection between the pursuit of building a strong education system and the upgrading of industry, with AIGC technologies injecting new momentum into its high-quality development. The TFS-SRIE Practical Model developed in this study, centered on Scenario development, resource generation, instructional adaptation, and assessment optimization, and supported by safeguards across the three assurances of technical specifications, teacher capacity, and

school–enterprise collaboration, provides a systematic solution to the developmental challenges faced by the AIGC-empowered secondary vocational Coffee Preparation Course.

To overcome the limitations of traditional theory-based instruction, interactive Curriculum resources integrating multimodal content should be developed, leveraging AIGC's dynamic generation capabilities to transform abstract principles of coffee science and sensory application into visualized 3D models and immersive animations, thereby enhancing students' concrete understanding. At the same time, a personalized knowledge delivery mechanism should be established, whereby intelligent diagnostic systems precisely analyze students' cognitive foundations and learning styles to automatically generate individualized learning pathways and training content, enabling a shift from uniform content transmission to personalized guidance. In addition, a dynamic system for updating industry-leading knowledge must be constructed, using AIGC to track in real time technological innovations and evolving standards in the coffee industry, ensuring that theoretical instruction remains consistently aligned with industry development and comprehensively advancing the intelligent transformation of AIGC-supported theoretical teaching. At the level of practical instruction, efforts should focus on the core demands of resource alignment, scenario authenticity, and precision guidance in current secondary vocational Coffee Preparation Course, with the aim of constructing an intelligent training system that integrates virtual and physical elements. By integrating diverse AIGC technologies, virtual simulation training platforms capable of replicating real workplace scenarios can be established, enabling students to engage in repeated practice within highly realistic environments at low cost and without risk. Priority should be given to the development of intelligent assessment systems based on multidimensional data collection, using sensors and computer vision technologies to comprehensively record students' operational processes and employing AIGC algorithms to generate precise skill diagnostic reports and personalized improvement plans. At the same time, an industry–education collaborative mechanism for cultivating innovative capacity should be established, transforming real enterprise projects into instructional cases and guiding students to apply AIGC tools in product development and process optimization, thereby systematically fostering job adaptability and innovative thinking. Through the dual-driven integration of theoretical and practical instruction, a profound shift from traditional experience-based teaching to data-driven intelligent pedagogy can ultimately be realized, comprehensively enhancing the instructional quality and talent cultivation outcomes of secondary vocational Coffee Preparation Course.

In summary, the successful implementation of Coffee Preparation Course pathways in secondary vocational institutions in the future will require the continuous refinement of technical application standards to ensure the educational value and scientific rigor of AIGC-generated content. Second, emphasis should be placed on the integrative innovation between the strengths of traditional pedagogy and intelligent technologies, so as to avoid falling into the trap of technology determinism. In addition, dynamic mechanisms should be continuously optimized by iteratively refining specific measures for each pathway based on implementation outcomes, while exploring the application boundaries and innovative potential of AIGC technologies across different vocational disciplines to sustain improvements in the quality of talent cultivation. The implementation pathways proposed in this study are not only applicable to secondary vocational Coffee Preparation Course but also provide transferable references for the digital transformation of other disciplines, offering new developmental pathways for cultivating composite vocational and technical talents in China and supporting vocational education in better serving industrial upgrading and the construction of an education powerhouse.

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