The Teacher-AI-Student Triadic Model in Vocational Education: A Literature Review on Cultivating Core Competence in Business Administration Students

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Abstract **–The integration of artificial intelligence (AI) in vocational education has introduced transformative teaching and learning methods. The "teacher-AI-student" triadic education model represents a paradigm shift, especially in higher vocational colleges, where cultivating vocational core competence is crucial for students' employment preparation. This paper integrates the existing research results on the interactive relationship between AI-driven teaching and traditional teacher-led teaching in cultivating the vocational skills of students majoring in business administration through a literature review. The research adopted a systematic literature screening method, mainly referring to peer-reviewed journal articles and conference papers in databases such as Scopus, Web of Science, Google Scholar and China National Knowledge Infrastructure (CNKI). The analysis criteria include its relevance to AI-assisted vocational education, theoretical perspectives, and practical impacts on students' learning outcomes. Research has found that artificial intelligence can enhance the effectiveness of personalized learning, knowledge acquisition and adaptive teaching, but there are still limitations in emotional support and social interaction. This requires a balance and collaboration between teachers and AI. Challenges such as the digital divide, teacher adaptability and ethical issues remain key obstacles to the promotion of AI in vocational education. This paper also points term impact of AI-driven education on vocational out several blank areas in current research, such as: the long- competence, effective models for teachers' collaboration with AI, and the role of AI in the cultivation of soft skills, etc. Filling these research gaps will help optimize the integration of AI in vocational education and promote the all-round development and career preparation of students.**

Keywords **– AI in education, Teacher-AI-Student model, vocational education, business administration, vocational core competence, constructivist learning, personalized learning**

I. INTRODUCTION

Background & Rationale

The integration of artificial intelligence (AI) in the field of education has transformed from an initial technological innovation into a transformative force, reshaping teaching practices in various educational scenarios. In recent years, AI applications such as personalized learning environments, intelligent tutoring systems, learning analysis and predictive modeling has received extensive attention due to their potential in supporting differentiated teaching and enhancing student engagement(Lin et al., 2023). These advancements are particularly significant in the field of vocational education, as it not only requires students to master theoretical knowledge but also to cultivate practical competencies that match the rapidly changing demands of the labor market.

Against this background of the "teacher-AI-student" triadic model emerged as a novel teaching framework, redefining the roles of educators and learners in the AI-enhanced learning environment. This model does not view AI as an auxiliary tool, but envisions it as an active teaching collaborator - a teaching partner capable of enhancing the teaching process through real-time adaptation, data-driven insights, and situational feedback (Sarker et al., 2024). In business administration programs, students' learning outcomes are usually evaluated through performance-based tasks and professional simulations. Intelligent systems have great potential in personalized learning paths and strengthening competency-oriented teaching.

However, scholars also warn against overemphasizing the capabilities of AI. Baker and Smith (2019) pointed out that although AI systems have powerful computing capabilities, it is still difficult to replicate the subtle aspects of human teaching that have interpersonal and ethical dimensions, such as emotional guidance, moral reasoning, and the guidance of critical discussions (Baker et al., 2019). Therefore, the "teacher-AI-student" model does not imply the replacement of the teacher's role, but rather the enhancement of the teacher's role. Owing to this model, teacher still undertake the core responsibility of organizing the learning process, while AI provides support for teachers' teaching decisions by continuously monitoring students' progress and behaviours.

In vocational education, the introduction of AI is particularly promising because it can simulate real working environments and provide students with immersive experiential learning opportunities. Ai-driven environments (such as virtual simulation, automated assessment, and interactive training modules) can reproduce industry practices, thereby effectively bridging the gap between classroom teaching and career preparation (Ghosh & Ravichandran, 2024). This approach is in line with the concept of "co-agency" that is increasingly emphasized in current education, that is, the collaboration between human intelligence and machine intelligence to jointly support the autonomous and adaptive development of learners.

Nevertheless, the application of AI in education also faces many challenges. Issues such as data privacy, algorithmic bias, unbalanced infrastructure, and teachers' digital capabilities continue to affect the success and scalability of the AI teaching model(Chen et al., 2020; Williamson & Eynon, 2020). These problems are particularly prominent in higher vocational colleges in Guangxi, China, as the gap in technology acquisition and

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teacher training may limit the effective deployment of AI systems.

In view of the above complexity, this paper proposes the "teacher -AI- student" triadic education model as a strategic and context-sensitive path, aiming to integrate human wisdom and technological advantages to optimize vocational education and teaching. By exploring how this model supports the development of the core professional abilities of business administration students, this paper aims to provide theoretical clarification and practical guidance, and promote the effective integration of intelligent technology in the vocational education teaching environment.

Research Objectives

Facing the trend of educational transformation driven by the continuous development of artificial intelligence (AI) technology, this paper aims to explore the application effect and practical significance of the "teacher-AI-student" triadic education model in the context of vocational education. The core purpose of the research is to analyze how this model contributes to the cultivation of the core vocational competencies of students majoring in business administration in higher vocational colleges in Guangxi region of China. To achieve this goal, the study pursues the following specific objectives:

1. To examine the theoretical foundations of the teacher-AI-student triadic model which will be investigated through the lenses of constructivist learning theory, social learning theory, and competency-based education framework.
2. To synthesize existing empirical research based on the role of AI technologies—such as personalized learning environments, adaptive feedback systems, and intelligent tutoring platforms—in enhancing vocational skill development.
3. To investigate the changing roles of teachers in AI-enhanced learning environments, focusing on how educators interact with, adapt to, and co-facilitate learning alongside AI systems.
4. To identify the main challenges, criticalities, and risks in the integration of AI into vocational education, including issues related to digital access and equity, critical thinking and strategies for fact checking, misuse, data ethics, and teacher preparedness.

II. THEORETICAL BACKGROUND

The teacher-AI-student triadic model uses an interdisciplinary perspective to explain how artificial intelligence (AI) can be effectively integrated into vocational education. This framework combines human teaching intuition with machine-driven adaptability to support the development of cognitive and applied skills. This model is based on constructivist learning theory, social learning theory and competency-based education, laying a solid foundation for understanding the continuous development of AI-enhanced teaching in business administration courses.

Constructivist Learning Theory

Constructivism holds that learners actively construct knowledge through experience, social interaction and situational participation. AI technology, especially tools involving adaptive learning and generative feedback are naturally in line with this concept. Tools such as Intelligent Tutoring Systems (ITS), virtual reality (VR), and AI-driven simulation platforms provide students with exploratory learning experiences that simulate real-world challenges, which is crucial for vocational college students (Holmes & Tuomi, 2022; Zawacki-Richter et al., 2019).

The latest development of generative AI has further strengthened constructivist learning. For instance, tools like ChatGPT and AI-supported context-building platforms provide support for problem-based learning, enabling students to test business strategies or play the roles of entrepreneurs and managers in role-playin (Liang, 2024). These technologies promote students' autonomy, creativity and decision-making ability - these qualities are particularly important in vocational education. Furthermore, AI can also achieve differentiated teaching, adjusting the content difficulty in real time based on students' performance (Chen et al., 2020). Then aims to establishing personalized learning paths that align with the self-directed learning concept emphasized by constructivism, while meeting the readiness and style requirements of different learners.

Social Learning Theory

Bandura's (1977) social learning theory emphasizes the importance of observational learning, imitation and social role models. Although AI systems can provide personalized teaching, they still fall short in cultivating empathy, emotional resonance, and genuine social interaction. As Mhlanga and Moloi (2020) pointed out, teachers still have irreplaceability in guiding human morality, cultivating social responsibility and interpersonal communication skills. (Mhlanga & Moloi, 2020).

AI works best when integrated into the social learning environment, that is, teachers mediate peer interaction, guide emotional development and demonstrate critical thinking. The "teacher- AI -student" model advocates the construction of an integrated ecosystem, in which AI is responsible for data-based teaching, while teachers play the roles of mentors, motivators and ethical role models (Holmes, Wayne; Bialik, Maya; Fadel, 2023). This hybrid model is particularly important in the vocational education environment. Students not only need to master technical tasks but also deal with the complex social relationships in the workplace. Teachers can provide contextualized explanations for AI-generated content and offer meaningful feedback, thereby promoting the improvement of students' collaboration, leadership, and cultural awareness - all tasks that AI cannot accomplish alone.

Competency-Based Education

Competency-Based Education (CBE) emphasizes measurable learning outcomes, the mastery of specific skills and authentic evaluations consistent with real needs. Because AI has the ability to provide real-time analysis,

personalized learning paths and performance-based feedback, it is particularly suitable for supporting CBE (Kastrati et al., 2021; Q. Zhang, 2024). By continuously monitoring students' progress, the AI system can diagnose skill gaps and adjust teaching content accordingly. In vocational business administration education, such tools can simulate working scenarios such as budgeting and strategic planning, enabling students to apply what they have learned in real contexts and obtain immediate and accurate feedback. These functions of AI are highly consistent with the core principles of CBE, enhancing the accuracy of teaching and students' employment-preparation capabilities. AI-driven dashboards can be used to monitor students' development in key abilities such as financial analysis, strategic planning, and customer relationship management. The virtual internship and AI simulation platform enables students to participate in industry-related task scenarios without leaving the classroom and achieve the assessment of their real performance (Rosário & Raimundo, 2024). In addition, AI also promotes formative assessment, which can identify learning blind spots and recommend personalized resources, thereby helping students make up for their deficiencies. This approach enhances students' learning initiative and promotes their sense of responsibility and goal orientation - which is precisely the core value of CBE (Kastrati et al., 2021; Panigrahi, 2020).

In summary, the "teacher-machine-student" ternary education model integrates the above three theoretical perspectives to construct a coherent and future-oriented vocational education model. This model not only supports the acquisition of technical capabilities, but also promotes the cultivation of cognitive flexibility, emotional intelligence and social adaptability - all of which are increasingly important capabilities in the digital labor market.

III. LITERATURE SELECTION AND ANALYSIS

This study adopts the method of systematic literature review to comprehensively understand the existing research related to the "teacher-AI-student" education model in vocational education. The following content will elaborate on literature search strategies, inclusion and exclusion criteria, as well as methods for literature classification and analysis

Search Strategy

Literature search was comprehensively carried out from multiple academic databases such as Scopus, Web of Science, Google Scholar and China National Knowledge Infrastructure (CNKI). To cover the breadth of related research, multiple combinations of keywords were adopted in the search, such as "Artificial Intelligence and Vocational Education", "teacher-AI-student model", "Vocational competence cultivation", "AI and Personalized Learning", "Intelligent Tutoring System and vocational Training", etc. These key words aim to focus on the core issues of the literature review, especially the integration of artificial intelligence in vocational skills teaching. To maintain the focus and timeliness of the review, the literature screening is limited to the period from 2010 to 2024, with a particular emphasis on research achievements published in the past five years, in order to reflect the latest technological and teaching developments. Priority should be given to peer-reviewed journal articles, academic conference papers and systematic reviews, especially those that balance theoretical perspectives and practical applications. The representative studies of Zawacki-Richter et al. (2019), Holmes et al. (2023), and Wijayati et al. (2024) were regarded as important references for this review (Zawacki-Richter et al., 2019; Holmes et al. 2023; Wijayati et al., 2024).

Inclusion and Exclusion Criteria

To ensure the relevance and quality of the selected literature, clear inclusion and exclusion criteria were established in this study. The inclusion criteria include: research published in English or Chinese, passing peer review, and directly focusing on the application of artificial intelligence in vocational education or competency-based learning environments. Furthermore, research involving teacher-student-AI interaction, or exploring personalized learning platforms, intelligent tutoring systems, and the application of generative AI in education, is regarded as highly relevant.

In contrast, the following types of research were excluded: literature that only focuses on general higher education and has no relevance to vocational education; Articles lacking theoretical frameworks or empirical data, such as opinionative essays, editorials, industry reports, etc. And papers that only discuss AI from a technical perspective without applying it to educational practice. After screening by applying the above criteria, a total of 46 core studies were finally selected as the basis for the subsequent integration and analysis of this review.

Data Categorization and Analysis

After screening out the relevant literature, the research team conducted a detailed review of each piece of literature and classified and organized them based on key themes. The primary concern is the theoretical framework on which these studies are based. A large number of documents are based on constructivist learning theory, social learning theory and competency-based education - these three are precisely the theoretical pillars of the "teacher-AI-student" education model (Mhlanga & Moloi, 2020; Zawacki-Richter et al., 2019).

The second type of research focuses on the practical application of AI tools in vocational education, covering intelligent tutoring systems, adaptive learning technologies, virtual simulations, etc., to support students' learning in mastering hard skills and soft skills(Holmes & Tuomi, 2022; Kastrati et al., 2021). These tools play a crucial role in achieving personalized learning and real-time feedback.

Another important topic is the transformation of the role of teachers. In the AI-integrated classroom, although some tasks can be automated, multiple studies have pointed out that human teachers are still indispensable in providing emotional support, guiding complex thinking, and cultivating ethical value (Fitria, 2021; Mnguni, 2024).

Finally, the analysis also focused on the challenges and obstacles faced by vocational education institutions in the

process of introducing AI, such as unequal access to technology, data privacy issues, and the need for AI literacy training for teacher (Du Plooy et al., 2024; Panigrahi, 2020).

By organizing and classifying the literature around the above four major themes, this study not only revealed the common findings in the research, but also identified the research gaps worthy of further exploration. This lays the foundation for the in-depth discussion of trends, innovations and unresolved issues in the next part.

IV. RESEARCH STATUS: AI'S ROLE IN VOCATIONAL EDUCATION

The integrated development of artificial intelligence in vocational education is rapid, bringing both opportunities and challenges. This section aims to integrate the current research findings on the functions and limitations of AI in the context of vocational education, with a focus on exploring its interactive relationship with teaching practice and the cultivation of vocational competences.

AI as a Knowledge Facilitator

Artificial intelligence, especially Intelligent Tutoring Systems (ITS) and adaptive learning platforms, has become an important tool for enhancing knowledge acquisition in vocational education. These technologies can analyze students' learning responses in real time and adjust the teaching content accordingly, enabling learners to make continuous progress along personalized path (Holmes & Tuomi, 2022; Lin et al., 2023; Saputra et al., 2023). AI systems can automatically handle repetitive teaching tasks, conduct timely formative evaluations, and provide targeted remedial teaching - these capabilities are particularly important in the face of large or diverse vocational classrooms. Although AI has an efficiency advantage in knowledge imparting, there are still obvious limitations in areas that require emotional intelligence, ethical judgment, and motivation support. Sethi and Jain (2024) pointed out that although AI can effectively convey teaching content, it lacks the ability to identify and respond to learners' emotional and interpersonal needs. This limitation is particularly prominent in vocational education, as vocational preparation not only relies on technical knowledge, but also involves social interaction skills, ethical decision-making ability, and self-motivation when facing real challenge (Ochieng, 2024; Panigrahi, 2020; Sethi & Jain, 2024). Therefore, AI should be regarded as a teaching assistance system - valuable in content delivery, but not sufficient to independently assume the role of an educator.

The Role of Teachers in AI Integration

The introduction of AI has not weakened the importance of teachers; instead, it has redefined their roles. In AI-enhanced classrooms, teachers play the roles of mentors, facilitators and ethical guides, providing human supervision and social emotional support that AI cannot replicate(Fitria, 2021; Mnguni, 2024) . Teachers can interpret the data generated by AI, connect learning situations with real professional scenarios, and ensure that students maintain their learning motivation and emotional connection.

As noted by Zawacki-Richter et al. (2019), successful application of AI in education depends on teachers' abilities in digital skills and teaching adaptability. Teachers must master AI tools and apply the data insights they provide to optimize teaching decision (Zawacki-Richter et al., 2019). If there is a lack of conscious intervention from teachers, AI may be detached from the cultural and emotional background of learning, especially in vocational education with strong practicality and frequent social interactio (H. Zhang et al., 2025). Therefore, it is necessary to provide professional development training to help teachers view AI as a teaching partner rather than merely a technical tool.

Development of Core Vocational Competence

The latest research shows that AI tools play a significant role in the cultivation of core professional abilities. Through interactive simulation, contextualized assessment and automated performance tracking, AI systems provide learners with the opportunity to practice job-related skills in a low-risk environment (Kastrati et al., 2021; Odum et al., 2021). These functions are in line with the principle of competency-based education, which emphasizes verifiable skills and job readiness rather than merely the duration of study.

In fields such as business administration, generative AI tools are being explored to support communication training, critical thinking, and problem-solving. For example, conversational AI tools such as ChatGPT or subject-specific tutoring robots can assist students in conducting conversational learning, simulating customer interactions or planning business strategies in real tim (Holmes & Tuomi, 2022; Kasneci et al., 2023). Although these innovations have potential, the research also points out that AI has limitations in supporting the development of soft skills such as leadership, empathy and teamwork - these skills are more difficult to quantify and rely more on human demonstration (Panigrahi, 2020; Rosário & Raimundo, 2024).

Generation Z's Learning Preferences

Today's vocational education learners are mainly from Generation Z. They grew up in a digital technology environment since childhood and have distinct expectations for their learning experiences. They prefer highly interactive, mobile and gamified learning methods, and attach importance to immediate feedback and visually appealing conten (Samuel et al., 2023; Saxena & Mishra, 2021). Ai-driven learning platforms respond well to these preferences by offering modular learning, progress dashboards, and adaptive content orchestration, enhancing the sustainability and appeal of learning.

However, scholars also caution against overly relying on technology to meet students' preferences. Although digital tools can enhance short-term engagement, they cannot replace deep-level social and emotional interactions, which are crucial for long-term learning outcomes and the construction of professional identitie (Mhlanga & Moloi, 2020). The currently more ideal path is to combine the efficiency of AI with the interpersonal relationship

advantages of teachers to construct a blended education model. Such integration can simultaneously promote the dual development of technical capabilities and interpersonal qualities, ensuring that students not only possess employability but also have the social and ethical qualities to adapt to the workplace.

V. RESEARCH CHALLENGES AND CONTROVERSIES

Although the integration of artificial intelligence in vocational education has brought transformative opportunities, it is also accompanied by many complex challenges, including limitations in emotional and ethical aspects, issues of educational equity, insufficient adaptability of teachers, and concerns about students' data privacy. This section will explore the main controversial points surrounding the "teacher-AI-student" triadic education model.

Emotional and Social Limitations of AI

There is no denying on that artificial intelligence has significant advantages in providing personalized content and automated assessment, there are still fundamental deficiencies in replicating human emotional and social intelligence. Sethi and Jain (2024) pointed out that artificial intelligence lacks empathy, moral reasoning, and a delicate understanding of human behaviour, which are crucial in vocational education, especially in fields such as business administration that emphasize interpersonal communication and emotional awareness (Sethi & Jain, 2024).

Human educators are not only disseminators of knowledge, but also guides, motivators and emotional supporters. They can capture students' subtle social signals, adjust teaching strategies according to students' emotions, and offer encouragement at critical moments. This is an ability that machines cannot replac. Zawacki-Richter et al. (2019), Holmes et al. (2023), and Wijayati et al. (2024) warned that excessive reliance on artificial intelligence might lead to emotional alienation or reduced learning engagement among students. Especially those students who need high-frequency interaction and personalized support (Holmes, Wayne; Bialik, Maya; Fadel, 2023; Wijayati et al., 2024; Zawacki-Richter et al., 2019). It must also be mentioned that, the irreplaceable role played by teachers in vocational education becomes increasingly prominent.

Equity and Accessibility Issues

The application of artificial intelligence in vocational education shows a highly uneven development trend. There are obvious gaps between different regions, between schools with abundant resources and those with scarce resources, and between institutions with advanced technology and those with insufficient preparation. As Mhlanga and Moloi (2020) pointed out, this inequality in access to AI infrastructure and training may instead exacerbate the education gap rather than bridge it (Mhlanga & Moloi, 2020).

Take Guangxi as an example. Due to the lagging infrastructure construction in some areas, some schools and students find it difficult to enjoy the same AI educational resources as those in cities or key universities. Furthermore, the issue of educational equity is not limited to the hardware level only. Zawacki-Richter et al. (2019) highlight issues that language barriers, cultural inadaptability of the content, and the lack of localized AI applications would all limit the educational effectiveness of AI. To achieve fair and culturally adaptive AI education, it is necessary not only to increase investment at the technical level, but also to promote inclusive reforms in content design and teacher support system (Zawacki-Richter et al., 2019).

Educator Adaptability and Training

The transformation of artificial intelligence-assisted teaching requires teachers to change their roles and master new competencies. However, many vocational education teachers still lack the digital literacy and teaching framework needed to effectively integrate AI into the classroom. According to Alenezi, (2023) and Kalniņa et al. (2024), this underpreparation is accompanied by teachers' anxiety about occupational safety and uncertainty about the role positioning of AI (Alenezi, 2023; Kalniņa et al., 2024).

In this process, institutional support is particularly crucial. If there is a lack of clear policy guidance, sufficient training opportunities and a new technological environment available for trial, many teachers will find it difficult to truly participate in AI-assisted teaching. Tammets and Ley. (2023) argued that the potential of AI tools is often greatly underestimated in the absence of corresponding investment in teacher capacity building (Tammets & Ley, 2023). In order to prevent AI teaching from being superficial, it is necessary to organically integrate AI technology with teaching goals through systematic teacher professional development projects.

Ethical and Privacy Concerns

AI systems rely on a large amount of learner data, which raises a series of sensitive issues such as privacy protection, monitoring risks, and algorithmic accountability. Although personalized learning systems offer many benefits, at the same time, the questions of how student data is collected, stored and used must also be answered, especially when students lack awareness of their data rights and the consequences of data sharing. These problems are more serious (Kastrati et al., 2021; Zawacki-Richter et al., 2019).

Furthermore, AI systems are not impartial. If the algorithm training data is incomplete or unrepresentative, it may unintentionally reinforce the existing inequality structure, resulting in some students being treated unfairly in terms of socioeconomic background, ethnicity or other demographic characteristics. Holmes and Tuomi (2022) emphasized that a sound ethical framework and governance system must be established to ensure the transparency, fairness and accountability of artificial intelligence application (Holmes & Tuomi, 2022). Only through such a guarantee mechanism can trust be established in AI-assisted education and the rights and interests of all learners be effectively protected.

VI. FUTURE RESEARCH DIRECTIONS

Summary of Key Findings

The integration of artificial intelligence (AI) in vocational education, especially through the "teacher-AI-student" ternary education model, is reshaping teaching practices and ability cultivation strategies. This model, by promoting personalized teaching, real-time feedback and adaptive learning experiences, better meets the development needs of vocational education, especially those of business administration majors (Alenezi, 2023). However, although artificial intelligence has obvious advantages in cognitive skills improvement and teaching efficiency, it still cannot replace the guidance, empathy and emotional support provided by human teachers(Holmes, Wayne; Bialik, Maya; Fadel, 2023; Samuel et al., 2023). Therefore, a balanced and collaborative educational model, that is, a combination that fully leverages the respective strengths of AI and teachers, is crucial for cultivating comprehensive professional abilities. Furthermore, literature research has also revealed several key challenges, including issues such as insufficient adaptability of teachers, infrastructure differences, ethical risks, and algorithmic biases. Only by solving these problems can the potential of AI in the field of vocational education be truly unleashed (Mhlanga & Moloi, 2020; Zawacki-Richter et al., 2019).

Research Gaps and Future Directions

Although the integration of AI in vocational education has attracted widespread attention, there are still many research gaps at present. First of all, longitudinal studies need to be conducted to evaluate the long-term impact of AI-assisted learning on vocational competence and workplace preparation. At present, most studies focus on short-term effects and have not been able to fully prove its continuous impact on students' career development.

Secondly, there is still a lack of a clear operational framework to define the effective collaboration mechanism between teachers and AI. Existing literature often regards AI as a tool rather than a co-participant in the teaching process. Future research needs to construct a more explicit co-teaching strategy model, which is particularly suitable for courses centered on skills training.

Thirdly, research at the ethical and policy levels urgently needs to be strengthened. As AI is highly dependent on personal data and algorithm processing, issues such as privacy protection, bias problems, and data governance need to be given priority attention to ensure the fairness and credibility of the implementation of AI education.

Fourth, although AI performs well in supporting technical learning, its role in cultivating soft skills such as teamwork, communication, and leadership still awaits in-depth exploration. In the future, a hybrid model combining human mentors and AI assistance can be explored to achieve the comprehensive cultivation of professional abilities.

Finally, most of the current AI systems originate from a Western background and fail to fully reflect local languages, learning styles and industry demands. Future research should focus on developing AI tools with cultural adaptability and localization characteristics, especially in the vocational education system of underdeveloped areas.

VII. CONCLUSION

The triadic education model of "teacher - AI - student" provides a promising new paradigm for the transformation of vocational education. By combining the adaptive functions of AI with the irreplaceable humanistic care of teachers, this model is expected to provide a more personalized, inclusive and effective learning experience. However, the success of this integration not only depends on technological progress, but also requires scientific instructional design, a sound ethical guarantee mechanism and continuous investment in teachers' development. Future research and policy must work in tandem to ensure that AI in education serves as a bridge toward equity and excellence—not a barrier.

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