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Evaluating the Effectiveness of Intelligent Teaching Models: A Comparative Study Between Traditional and AI-Enhanced Instruction in Undergraduate Vocational Universities in China

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ABSTRACT

BACKGROUND & CONTEXT

AI transforms education via personalized, interactive learning. In vocational education (critical for practical skills), traditional teaching often fails diverse needs. AI offers tailored feedback and adaptive paths, yet its effectiveness vs traditional methods is underexplored—this study fills the gap in China's undergraduate vocational universities.

PURPOSE OR GOAL

The research evaluates whether AI-enhanced instruction improves learning outcomes, engagement, and skill application compared to traditional teaching. The study hypothesizes that AI's adaptive capabilities and real-time feedback lead to better educational effectiveness.

APPROACH OR METHODOLOGY

The research evaluates whether AI-enhanced instruction improves learning outcomes, engagement, and skill application compared to traditional teaching. The study hypothesizes that AI's adaptive capabilities and real-time feedback lead to better educational effectiveness.

OUTCOMES

Findings reveal that AI-enhanced instruction significantly improves learning outcomes, with higher scores in practical application (mean = 4.54) and critical thinking (mean = 4.48). Traditional methods showed limited impact ($R^2 = 0.043$), whereas AI models accounted for 74.4% of variance in effectiveness ($R^2 = 0.744$).

CONCLUSIONS

AI-enhanced instruction demonstrates superior effectiveness in vocational education, particularly in fostering practical skills and engagement. These results underscore the need for curriculum reform and teacher training to integrate AI technologies effectively.

KEYWORDS

Artificial Intelligence; Educational Technology; Vocational Education.

Introduction

Recent advancements in Artificial Intelligence (AI) are revolutionizing education by transforming knowledge transfer and teaching methods (Alam, 2020). Intelligent Education powered by AI customizes instruction, boosts engagement, and improves outcomes (Cantú-Ortiz et al., 2020., 2020), addressing traditional teaching's limitations (Chen, Chen, & Lin, 2020).

In higher education, AI offers personalized instruction and real-time feedback, enhancing performance by 15 - 22% over traditional lectures (Aleven et al., 2022; Chan, 2023). However, vocational education faces significant challenges. Standardized curricula and limited practical resources hinder its ability to meet diverse learner needs and industry demands (Altbach et al., 2019; Yue & Wang, 2025). A survey revealed that 78% of Chinese vocational students lacked personalized guidance, and 63% could not apply knowledge practically (Yue & Wang, 2025).

Rooted in educational technology, AI has advanced to create adaptive, student-centered teaching models (Vincent - Lancrin & Van der Vlies, 2020; Pendy, 2023). It tailors learning to diverse styles, improving understanding and engagement (Tareen & Haand, 2020; Latif et al., 2023). Interactive elements like gamification, appealing to digital natives, further enhance learning (Adiguzel, Kaya, & Cansu, 2023).

Studies show AI outperforms traditional methods, with AI-driven platforms improving university performance (Chan, 2023) and tutors enhancing math problem-solving (Aleven et al., 2022).

Yet, AI integration faces challenges like data privacy, ethics, and the risk of replacing educators. Balancing its benefits and the human element is crucial (James, Wheelock & Woolliscroft, 2021; Dwivedi et al., 2023).

Background

Traditional teaching adopts a one-size-fits-all approach, struggling to accommodate diverse learning styles, speeds, and preferences, leading to varied engagement and comprehension. This inflexibility is particularly evident in higher education with diverse student backgrounds (Bahadur & Zhang, 2021; Altbach et al., 2019).

However, recent AI advancements enable personalized learning (Kadaruddin, 2023). Intelligent teaching models, integrating AI algorithms, dynamically adapt to individual paces, styles, and preferences, mitigating traditional drawbacks. They provide teachers with insights via real-time data analytics for informed instructional decisions (Alam & Mohanty, 2022; Owoc et al., 2019; Alam, 2021).

AI systems analyze student behavior, assess learning levels, and tailor content delivery—identifying difficult concepts and offering supplementary materials to enhance engagement and knowledge retention (Cutrer et al., 2021; Alam, 2023; Vincent-Lancrin & Van der Vlies, 2020). Empirical evidence shows AI-enhanced education improves academic performance, motivation, and self-regulation, while facilitating timely feedback to empower both teachers and students (Chiu et al., 2023; Carless & Boud, 2018).

Literature Review

AI - integrated education has led to intelligent teaching models, transforming instruction. This review compares their effectiveness with traditional methods in learning outcomes, engagement, personalization, feedback, and retention.

Learning Outcomes

AI-enhanced teaching improves learning outcomes. Chan (2023) and Aleven et al. (2022) found significant improvements in university students' performance and problem-solving. Tilley

(2019), Pelletier et al. (2021), and Kadaruddin (2023) also highlighted better academic performance, fundamental skill acquisition, and personalized learning environments.

Engagement and Motivation

Gamification in AI-enhanced instruction boosts engagement (Muñoz et al., 2023; Holstein et al., 2019). AI-driven personalization increases motivation (Akgun & Greenhow, 2021; Shi et al., 2020). Wang et al. (2022), Archibald et al. (2023), Kim, Lee & Cho (2022) showed that AI-enabled peer interactions and virtual mentors increase engagement.

Personalization

AI addresses diverse learning styles (Curum & Khedo, 2021). Wang et al. (2022), Hsiao et al. (2023), Mohammad Ali (2023), and Rad, Alipour & Jafarpour (2023) emphasized its role in increasing self-efficacy, meeting individual needs, and giving students a sense of control. Rachha and Seyam (2023) found it improves academic performance and soft skills.

Feedback Mechanisms

AI provides real-time, consistent, and detailed feedback (Murphy, 2019; Darvishi et al., 2022; Schachner, Keller & van Wangenheim, 2020), while human feedback offers sympathetic and context-sensitive understanding (Trang, 2021; Zhang & Hyland, 2018). A blended approach is advocated (Zhou, 2023; Dengel, Devillers & Schaal, 2021; Chan & Tsi, 2023).

Retention and Transfer

AI-enhanced instruction improves long-term retention (Singh & Hiran, 2022; Chaudhry et al., 2023). Pangrazi and Beighle (2019), Schlüter et al. (2021), Chan, Yat-Hang & Tsz Heung Agnes (2022), Qadir (2023), and Julia and Marco (2021) highlighted its role in knowledge application and effective transfer.

Methodology

Quantitative Approach

This study employed a comprehensive quantitative approach to measure students' perceptions of teaching effectiveness in traditional and AI-enhanced models.

Questionnaire Design

The questionnaire comprised four sections:

1. **Demographics:** Collected basic socio-demographic data like gender and age. For vocational education students, age was categorized as "18–21", "22–24", and "25+".
2. **Traditional Teaching Evaluation (5 items):** Assessed passive learning behaviors and teacher dependency.
3. **AI-Enhanced Teaching Evaluation (5 items):** Focused on interactivity, personalized feedback, and practical simulation.
4. **Effectiveness Evaluation (5 items):** Measured learning outcomes related to vocational skills.

All items used a 5-point Likert scale. The questionnaire underwent a "forward-backward translation" process by bilingual education experts to ensure cross-lingual validity.

Data Analysis

Quantitative data were analyzed using SPSS to compare teaching models and assess effectiveness. Testing procedures included validity, reliability, regression, correlation, descriptive analysis, and creation of dummy variables.

Results

Demographic Characteristics

- Gender: Out of 100 respondents, 51% were female and 49% were male.
- Age: 68% were aged 18 - 21, 20% were 22 - 24, and 12% were over 25.

Reliability Statistics

Cronbach's alpha was 0.830, indicating high reliability. Most responses among the 15 statements about the three variables were consistent.

Validity Statistics

- KMO value was 0.531, showing the sample was just about adequate for analysis (significance value = 0.000).
- Communalities: For traditional teaching, the variance was 0.185, whereas AI-enhanced teaching and its effectiveness showed variances of 0.894 and 0.884, respectively.

Descriptive Statistics

- **Traditional Teaching:** Mean values for the five statements ranged from 3.32 to 3.61. For example, the mean for "working hard is important for good grades in traditional teaching" was 3.61 (SD = 1.30).
- **AI - Enhanced Teaching:** Mean values ranged from 4.40 to 4.56. For instance, the mean for "AI encourages engagement through immersive learning" was 4.56 (SD = 0.85).
- **Effectiveness towards Students:** Mean values ranged from 4.47 to 4.54. For example, the mean for "students can learn effectively" was 4.47 (SD = 0.958).

Regression Analysis

- **Traditional Teaching:** $R = 0.208$, indicating a weak impact on student effectiveness. $R^2 = 0.043$, meaning only 4.3% of the variance in the dependent variable was due to traditional teaching. The significance value was 0.03, so the hypothesis that traditional teaching is effective was accepted, but its impact was limited.
- **AI - Enhanced Teaching:** $R = 0.863$, showing a very strong impact. $R^2 = 0.744$, indicating 74.4% of the variance in the dependent variable was caused by AI - enhanced teaching. The significance value was 0.000, so the hypothesis that AI - enhanced teaching is effective was accepted.

Correlation Analysis

- Pearson correlation for traditional teaching was 0.232, indicating a weak positive association.
- For AI - enhanced teaching, it was 0.863, indicating a high positive association.

Discussion

Core Advantages of AI - Enhanced Teaching in Vocational Skill Development

This study shows that AI - enhanced teaching is better than traditional methods in skill transfer and practical application in vocational education. The AI group had significantly higher scores in "preparedness for practical applications" (mean = 4.54, SD = 0.86) and "job competency alignment" (mean = 4.50, SD = 1.00), indicating that AI promotes skill development through immersive simulations (e.g., VR - based factory operations) and real-time feedback (e.g., instant error correction in assembly tasks). These findings align with Dewey's (1938) 'Learning

by Doing' theory, which emphasizes experiential learning in vocational contexts. In contrast, the traditional group had a low score in "active engagement" (mean = 3.32), reflecting its passive, lecture-driven model.

Quantitative Differences in Knowledge Retention and Skill Transfer

Data Validation: The traditional group had low scores in "independent knowledge summarization" (3.32) and "job - related problem-solving" (3.50), showing the limitations of its "teacher - centered" approach. The AI group's higher mean score in critical thinking (M = 4.48, SD = 0.94) suggests that adaptive learning paths enhance higher-order cognitive skills for vocational roles.

Theoretical Fit of AI in Vocational Education

The effectiveness of AI can be explained by three theories:

Social Cognitive Theory (Bandura, 1977): AI's immediate feedback (e.g., performance scores in virtual nursing simulations) boosts self - efficacy and motivation. The AI group's "learning motivation" mean (4.56, SD = 0.85) was significantly higher.

Situated Cognition Theory (Lave & Wenger, 1991): AI embeds learning in real vocational contexts (e.g., AI - powered e - commerce negotiation platforms), enabling "legitimate peripheral participation". 63% of the traditional group students reported "difficulty applying classroom knowledge".

Constructivist Theory (Vygotsky, 1978): AI acts as a "cognitive scaffold" by adjusting task difficulty. For example, mechanical engineering students progressed from basic assembly to fault diagnosis, while traditional fixed - difficulty models led to frustration.

Implications for Future Research

The findings made during the course of this study have profound and wide-ranging repercussions that cut across the range of educational activities. Integration into teaching models demands reimagining curriculum design, training educators, and adapting institutional infrastructure to accommodate this transformation.

As the educational environment readies itself for this historic change, it is abundantly clear that the incorporation of AI technology is not just a surface enhancement but a trigger for a profound revolution. Above all, this transformation necessitates a thorough rethinking of the way curricula are created and organized. In order for the traditional paradigms to work with the enhanced capabilities that AI brings to the fore, they must be reevaluated and calibrated.

In addition, it is crucial to recognize that the incorporation of AI into education calls for a strong framework for the training and ongoing professional development of educators. The traditional pedagogical method is no longer adequate, and teachers must have the necessary training to fully utilize AI. The inclusion of technical fluency, adaptability, and cutting-edge teaching strategies that smoothly integrate with AI-enhanced teaching models should be part of all teacher training programs.

The integration of AI into the educational fabric necessitates a fundamental infrastructure reconfiguration at the institutional level. In order to enable the smooth integration of AI-driven tools and platforms, the digital ecosystem needs to be adjusted. To accommodate the complexities and nuances that emerge along with the introduction of AI, administrative processes and rules that oversee educational institutions must be sensitive to this paradigm shift.

Conclusion

The incorporation of AI-enhanced instruction is emerging as a catalytic and revolutionary effect within the dynamic evolution of the educational arena. This study focuses on the amazing

potential of AI to change the learning environment at undergraduate vocational universities. A compelling body of evidence clearly demonstrates how tailored, AI-guided training may fundamentally alter learning outcomes and increase student engagement. The traditional frameworks of education find themselves on the verge of a seismic shift as educational stakeholders, including educators, institutions, and policymakers, gradually integrate AI technology. This change foreshadows a time when education will be more inclusive, immersive, and effective than it has ever been.

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Appendix

Questionnaire

Demographics

1. Gender

- Male
- Female

2. Age

- 18-21
- 22-24
- 25+

Independent variable 1: Traditional teaching model

Statements	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I was required to work hard to achieve good grades					
I feel I learnt a great deal in the class					
I relied on the professor to give me the information I needed to know in this class.					
I had to figure out what was important in this class and learn it myself.					
I am exposed towards regular standardized tests and assessments					

Independent variable 2: AI enhanced teaching

Statements	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
The inclusion of AI in the classroom encourages engagement through immersive and interactive learning opportunities					
The use of multimedia equipment as well as gamified activities help me to learn better					
I find AI-powered feedback and assessments valuable for my academic progress.					
AI-enhanced teaching tools help me better understand complex concepts.					
AI-enhanced teaching methods adapt to my individual learning pace and style					

Dependent variable: Effectiveness on students

Statements	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I am able to learn effectively					
I am adequately prepared for practical applications in my field of study.					
My critical thinking and problem-solving skills have improved significantly					
I am able to prepare for my future career aspirations effectively					
I can understand complex course materials effectively					

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