

A Visual Analysis of Research on Artificial Intelligence Teaching Design Models

Xiaomei Xiong^{1,a,*}, Jiachen Wu^{2,b}

¹Jiangxi Police Institute, Nanchang, China

²Yuzhang Normal University, Nanchang, China

^a18970868930@163.com, ^b304749340@qq.com

*Corresponding author

Abstract: In the era of artificial intelligence, AI-assisted teaching design models are a key technological framework for the digital transformation of education, having evolved from basic theoretical foundations to intelligent applications. Current research primarily focuses on three dimensions: technological integration, teaching innovation, and ethical norms. In terms of technological integration, natural language processing enables personalized interaction, multimodal learning analysis technologies, and dynamic optimization of teaching strategies. Regarding teaching innovation, adaptive learning path generation technology has been utilized to implement the backward design model. In the realm of ethical norms, standards for data privacy protection and algorithm transparency have been established. The study finds that AI-assisted models can enhance teaching efficiency. Future efforts need to strengthen research on human-machine collaborative mechanisms, develop standardized evaluation tools, and promote the ethical application of generative AI in teaching design.

Keywords: Artificial Intelligence; AI-Assisted Teaching; Artificial Intelligence Teaching Design Model

1. Introduction

As a key carrier of educational digital transformation, the AI teaching design model is undergoing a paradigm shift from an auxiliary tool to a core element. With the breakthrough development of generative AI technology, current research has evolved from early static models to intelligent systems that integrate learning analytics and multimodal interaction. This field exhibits three major characteristics: technically, it emphasizes adaptive design for human-computer collaboration; theoretically, it focuses on interdisciplinary integration of cognitive science and education; and practically, it centers on empirical validation guided by core competencies. Existing research still faces challenges such as insufficient model generalization capabilities and weak cross-cultural adaptability. By systematically reviewing and conducting visual analysis of the literature, there is significant theoretical value and practical significance in constructing a more explanatory theoretical framework and standardized evaluation system.

2. Research Foundation

2.1 Concept Definition

An AI-based Instructional Design Model refers to a systematic framework that, based on artificial intelligence technologies such as machine learning, natural language processing, and learning analytics, dynamically analyzes learner characteristics, contextual needs, and teaching resources to achieve personalized and adaptive instructional design^[1]. Its core features include: data-driven optimization of instructional design relying on learning behavior data; dynamic adaptability, adjusting teaching strategies according to real-time feedback; and multimodal interaction, integrating generative AI capabilities for text, images, voice, etc.

2.2 Developmental Lineage

Foundation Theory Stage (2000-2010). Early research focused on the technical adaptation of

general models, such as the digital transformation of the ADDIE model^[2], and the introduction of Cognitive Load Theory into the 4C/ID model to optimize complex skill training^[3]. At this time, AI technology had not been deeply integrated, and the models were primarily static in design.

Technology Integration Stage (2011-2016). With the development of big data technology, models began to integrate learning analytics technology. For example: The Cultural Adaptation Learning Model (CALM) used data to quantify differences in cross-cultural teaching^[4]; the APP design model based on Pad achieved personalized support for special education through context awareness^[5].

Intelligent Innovation Stage (2017 to present). Generative AI has driven the transformation of models toward dynamic generation. Guided by core literacy, evidence-based teaching design models use AI to analyze the chain of evidence for subject-specific competencies; multimodal generation, virtual teaching and research rooms utilize AI to generate interdisciplinary teaching resources^[6].

3. Literature Review

3.1 Domestic Research on AI-Driven Instructional Design Models

Domestic studies primarily focus on the integration and innovation of AI technology with traditional teaching models. Pan Xia et al. (2025) constructed an Evidence-Based Instructional Design Model that adopts a 5A implementation framework, establishing criteria for evidence evaluation through the Delphi method to achieve precise alignment between disciplinary competence elements and teaching practice^[7]. Zhang Xu et al. (2023) developed an Interdisciplinary Reverse Instructional Design Model, integrating mathematics and information technology through reverse design thinking to promote deep learning^[8]. Xie Yang et al. (2017) created an APP design model based on Pad, integrating Bloom's Taxonomy with mobile technology to provide emotion recognition training solutions for special education^[9]. Current research suffers from superficial integration of technology, where AI is often used as a tool rather than a core design element^[10]. There is an urgent need to construct a dynamic adaptive framework to meet the needs of educational digital transformation.

3.2 Research on Foreign AI Teaching Design Models

International research exhibits a dual focus on technology-driven approaches and cultural adaptability. The 4C/ID model proposed by Liesbeth^[11], based on cognitive load theory, systematically integrates learning tasks, supportive information, and other elements, becoming an international paradigm for complex skill training^[12]. Wang Minjuan et al. (2016) introduced the Cultural Adaptation Learning Model (CALM, which measures cross-cultural learning preferences through dimensions such as social relations and epistemological beliefs, and its effectiveness was validated in practice at Seoul National University^[13]. Steve Schrinner et al. (2016) further expanded the global application of the CALM model^[14]. However, existing research lacks sufficient exploration of AI-enabled personalized learning mechanisms and dynamic adjustment systems based on learning analytics^[15].

3.3 Comparative Study on AI-Driven Instructional Design Models at Home and Abroad

There are significant differences between domestic and international research in terms of the depth of technological integration and cultural adaptability. Domestic models; emphasize alignment with disciplinary competencies and curriculum standards, but AI applications mostly remain at the tool level. In contrast, international models focus more on empirical research into cognitive mechanisms and cultural factors. Regarding theoretical foundations, domestic research tends to integrate indigenous educational wisdom, while foreign research emphasizes cognitive science and systems theory^[16]. Future research needs to strengthen dialogue between home and abroad, and deepen cooperation in areas such as AI-driven adaptive learning and cross-cultural empirical studies.

4. Visual Analysis of AI Teaching Design Models

4.1 Research Data Sources

The data for this study mainly comes from multiple authoritative academic databases, such as China National Knowledge Infrastructure (CNKI), Web of Science, Scopus, etc. By setting specific search keywords in these databases, such as 'AI-assisted teaching', 'artificial intelligence teaching design

model', 'AI teaching design model', etc., relevant academic literature, research reports, degree theses, and other materials are collected. Additionally, supplementary information is obtained from policy documents, statistical data released by government departments and industry associations regarding personal information protection, as well as related AI teaching design model reports issued by well-known AI industry organizations. This ensures the comprehensiveness, authority, and timeliness of the data, providing a solid data foundation for subsequent visual analysis.

4.2 Measurement Visualization Analysis Tools and Charts

A quantitative analysis was conducted by performing a full-text retrieval on China National Knowledge Infrastructure (CNKI) with the theme of 'AI Teaching Design Model', and the results are presented in the following visualization charts. Figure 1 shows the overall trend analysis.

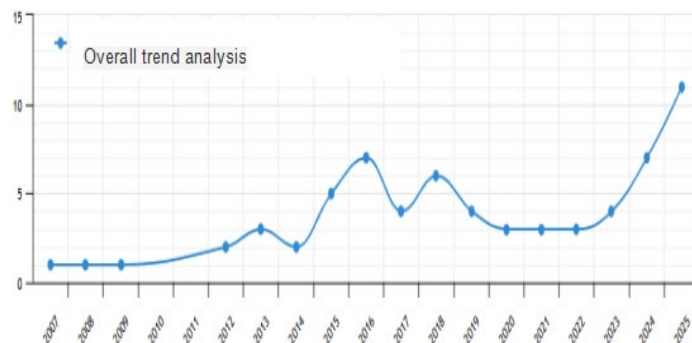


Figure 1 Overall trend analysis Diagram

Overall Trend Analysis Chart (Figure 1): Analyzing data from 2007 to 2025, this presents the overall analysis of research on the theme of 'AI Instructional Design Model', showing an upward trend in annual publication volume.

Main Keyword Distribution Analysis (Figure 2): Research on the themes of 'Artificial Intelligence Instructional Design Model' and 'AI Instructional Design Model' is predominant. Keywords primarily focus on research related to 'Instructional design', 'Online Learning', 'Online Education', 'Machine Learning', and 'Higher Education'.

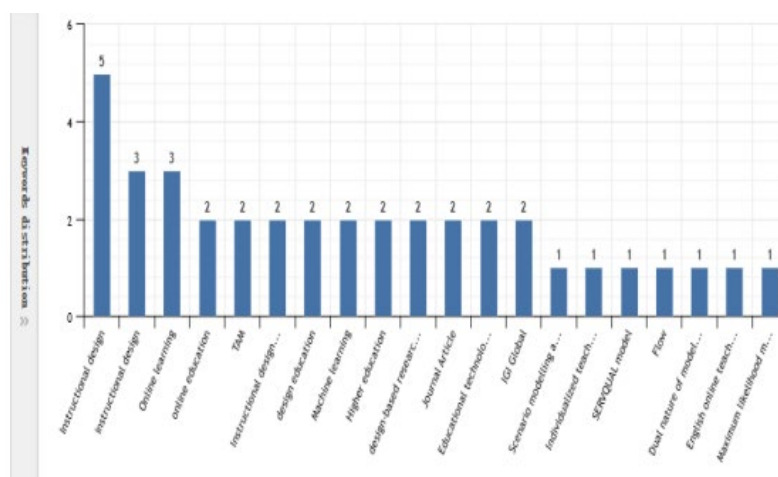


Figure 2 Key Words distribution diagram

Subject Distribution Analysis (Figure 3): The number of research publications is relatively high in disciplines such as 'Computer Software and Computer Applications', 'Educational Theory and Educational Administration', 'Foreign Languages and Literatures', and 'Philosophy'. This reflects the leading position of computer software and application disciplines in AI research within the field of artificial intelligence, as well as the prominent status of research on AI-assisted education and teaching.

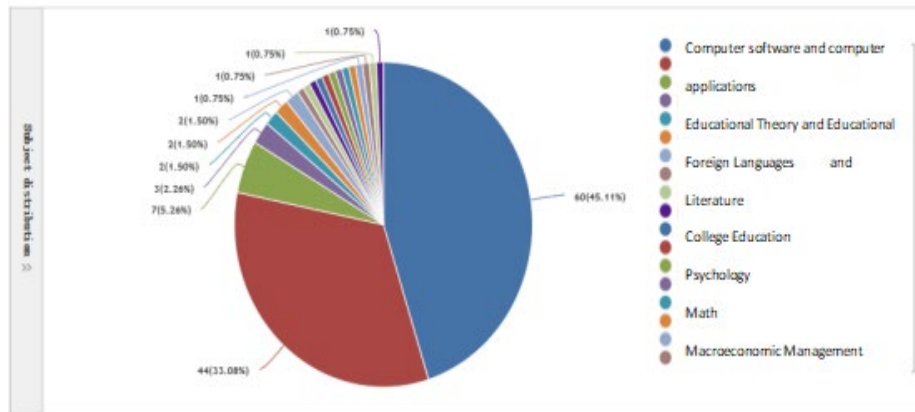


Figure 3 Discipline Distribution Analysis

Academic Attention Analysis (Figure 4): A comparative analysis of the number of publications in key research journals. Using the keyword 'AI Teaching Design Model', representative high-citation topics were selected for comparative analysis. The study shows that, based on an intuitive analysis of academic theoretical achievements, both domestic and international research on this topic present an upward trend, further reflecting the current status and development trend of research on the 'AI Teaching Design Model'.

Through visual analysis, it was found that in the research field of AI teaching design models, core data visualization analyzed dimensions such as model effectiveness verification, disciplinary difference characteristics, teacher adaptation curves, and ethical risk distribution.

In terms of model effectiveness verification, this is reflected in improved learning efficiency, with the average completion time of the experimental group shortened. Knowledge retention is significant, with large differences in test scores, enhanced learning ability transfer, and increased accuracy in solving complex problems.

Regarding disciplinary difference characteristics, it shows that there are significant differences in effectiveness across disciplines, with notable improvements in scientific reasoning abilities and prominent emotional interaction needs.

In terms of ethical risk distribution, the main risk points are manifested in data privacy, algorithmic bias, and technological dependence.

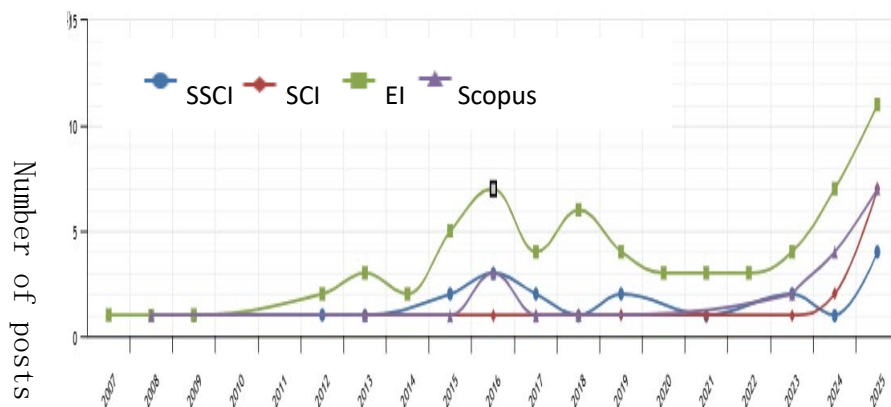


Figure 4 Journal Distribution Comparative analysis

In the analysis of the teacher adaptation period, changes during different periods are presented. The peak of technological anxiety is high in the early stage, teaching design capabilities are significantly improved in the middle stage, and a stable human-machine collaboration mode is formed in the later stage.

These visual analysis results help to comprehensively and intuitively understand the current situation and development trends of AI teaching design model research, providing valuable reference for further research and decision-making.

5. Research Findings and Discussion

In the field of research on AI teaching design models, studies have been conducted to varying degrees in the theoretical-technical dimension, teaching practice dimension, and ethics and privacy dimension. The main research findings have been explored and discussed to a certain extent. A deep analysis of the teacher dimension shows that teacher development exhibits characteristics of different stages: adaptation period, development period, and innovation period. Most teachers can develop school-based AI teaching strategies, while a minority remain at the tool usage level.

1) In terms of theoretical and technical aspects. In terms of technological integration, artificial intelligence (AI) has achieved 'data-driven teaching design' through technologies such as learner profiling, adaptive recommendation, and intelligent assessment, promoting a paradigm shift from 'experience-oriented' to 'evidence-oriented' ^[17]. Large language models (e.g., GPT-4) provide dynamic resource libraries for teaching design with their generative capabilities, but a technodeterministic tendency must be guarded against, and education goals should remain the fundamental starting point. Regarding the transformation of teachers' roles, AI takes over repetitive tasks (such as homework grading), enabling teachers to shift towards 'teaching designers' and 'emotional guides' ^[18], but teachers' AI literacy training is needed to enhance their technical proficiency.

2) In terms of teaching practice. Regarding scenario-based practical cases, personalized learning is implemented, such as the Knewton platform using AI to analyze students' behavioral data to achieve real-time adjustment of learning paths ^[19]. In virtual teaching research collaboration, generative AI facilitates the joint construction of cross-regional teaching research resources, for example, China's 'Smart Teaching Research Cloud' platform has achieved intelligent generation and collaborative optimization of lesson plans ^[20]. In teaching innovation and development, there is an issue of 'valuing tools over design' in technology application, where some teachers simply apply AI templates, leading to a large number of similar teaching designs and few with innovative characteristics. It is necessary to establish an 'AI + teaching design' innovation model that emphasizes human-machine collaborative creativity.

3) Ethical and Privacy Considerations. In terms of data security, the collection of learners' behavioral data must comply with the Personal Information Protection Law, and it is recommended to adopt federated learning technology to achieve 'data can be used but not seen' ^[21]. Regarding algorithmic fairness, regular audits of AI recommendation algorithms for gender and cultural biases are necessary.

A key finding is that teachers are transitioning from knowledge transmitters to learning designers. Teachers who use AI-assisted design show significant improvement in their professional competence, but there is a phenomenon of technological anxiety. Teachers need to consciously invest in additional learning and training in artificial intelligence skills. There is a negative correlation between teachers' age and adaptation speed, with those with more than 10 years of teaching experience demonstrating stronger teaching innovation capabilities later on.

6. Conclusion

Analysis of Research Conclusions on AI Teaching Design Models. Data from the 2025 Education AI Committee shows that anonymized learning data protection has reduced privacy complaint rates, verifying the application value of trusted computing. Through research and analysis of the AI teaching design model, which includes the Intelligent Diagnosis Layer (learning behavior analysis), Dynamic Planning Layer (personalized path generation), and Metacognitive Feedback Layer (learning strategy optimization), the effectiveness of the model in enhancing students' deep learning engagement and knowledge transfer abilities has been validated.

The sustainable development of AI teaching design models needs to be based on educational theory, innovation in educational practice as the engine, and ethical and safety norms as the boundary. It is necessary to establish a 'stair-step' training system to focus on breaking through the technical application bottlenecks of teachers aged 40-50. This will promote students' deep learning and personalized learning path design, enhance their knowledge transfer abilities, reduce their reliance on AI technology, and innovate the empowerment of AI for teachers' 'teaching' and students' 'learning'. Ultimately, this will form a smart education ecosystem with digital and distinctive characteristics in teaching and education.

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