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2025 Volume 3, Issue 4
Contemporary Education Frontiers
ISSN (Online): 3029-1860 ISSN (Print): 3029-1879

Research on Personalized Textbook Design Strategy and Application Path Empowered by Artificial Intelligence

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***A*bstract:** The rapid development of artificial intelligence technology is reconfiguring the education ecology and promoting personalized education as an important development direction. As an important medium for carrying knowledge content and transmitting teaching information, the digital transformation of teaching materials plays a particularly crucial role in the whole process of educational change. This study focuses on the design strategy and application path of AI-enabled personalized teaching materials, and proposes an AI-enabled personalized teaching materials innovation plan for the three core problems of traditional teaching materials: content updating lags behind the speed of knowledge iteration, standardized design is difficult to adapt to individual learner differences, and unidirectional delivery mode restricts the depth of teaching interaction. By integrating the technological advantages of generative AI and knowledge mapping, the study proposes a personalized teaching material design strategy of "dynamic generation, multimodal interaction, and closed-loop optimization", and constructs a three-layer implementation framework that includes technological integration, development process, and standard guarantee. Through theoretical analysis and case validation, the study provides a systematic solution for the development of intelligent teaching materials, which is of great reference value for the promotion of personalized education and the digital transformation of education.

Keywords: Artificial intelligence; Personalized teaching materials; Design strategies; Application paths

Online publication: May 26, 2025

1. Background

Teaching materials as a teaching tool is experiencing the emerging form of digitization, the current digital teaching materials presented in the form of "paper-based digital teaching materials, multimedia digital teaching materials, interactive digital teaching materials", etc. Through the development of digital teaching materials platform, artificial intelligence is involved in teaching materials and teaching is the trend of the future development of teaching materials. The development of personalized digital teaching materials to meet the needs and interests of different learners has become an important driving force for personalized education.

China currently has more participants in the development of digital teaching materials, how to effectively carry out the development of personalized teaching materials to help personalized education, and how to play the role of teaching materials as a tool in teaching and help teaching accurate drip irrigation is a problem worth thinking about. This study intends to explore the design and application of personalized teaching materials from the perspective of AI empowerment, and explore and research systematic solutions.

2. The Current Situation of Education Digitization and the Necessity of Personalized Teaching Material Construction

2.1. The Epochal Background of Education Digital Transformation

Currently, the global education field is experiencing a profound change centered on artificial intelligence technology. The digital transformation of education in the field of education also promotes the transformation of teaching materials from "stable, static and closed" to "diverse, dynamic and open". China's Ministry of Education and local education authorities have issued a number of policies to vigorously promote the construction of intelligent teaching platforms and resources, and to integrate them into the requirements for the construction of gold "hardware". The study found that generative artificial intelligence, as the engine of education digital transformation, is driving comprehensive innovation in the field of digital teaching materials and providing tools to support personalized learning. However, digital resources that truly realize personalized learning are still in the minority, and there is an obvious gap between the depth and breadth of technology application. This also reflects the systemic challenge of integrating technological innovation and teaching practice in the process of digital transformation of education, as well as the challenge of developing personalized teaching materials empowered by artificial intelligence.

2.2. Inherent Limitations of Existing Traditional Teaching Materials

Through the study of the existing teaching materials system, several key limitations have been identified: in terms of content updating, it is difficult for the revision cycle of traditional paper-based teaching materials to keep pace with the rapid iteration of knowledge; in terms of adaptability, the uniform content design cannot meet the diversified and personalized cognitive needs of learners; in terms of interactivity, the unidirectional mode of transmission of paper-based teaching materials restricts the teaching and learning process in the process of teaching and learning. In terms of interactivity, the unidirectional delivery model of paper-based teaching materials limits the dynamic adjustment in the teaching process under different "learning situations". These limitations are interrelated and constitute structural barriers to improving teaching effectiveness. In the field of vocational education, traditional teaching materials often cut off students' physical cognition, which is far away from the modern education concept that emphasizes the "unity of body and mind".

2.3. Potential of Artificial Intelligence Technology

Artificial intelligence technology provides a breakthrough solution for teaching materials innovation. The new textbook framework empowered by AI improves the systematic organization of knowledge based on knowledge mapping technology, and enhances the three-dimensionality of interaction through multimodal expression. Generative AI not only promotes the formation of a new view of teaching materials, but also expands the functions of teaching materials. In particular, digital teaching materials for vocational education that emphasize the cultivation of technical skill literacy need to be dynamically adapted to the differences in teaching scenarios, with diversified functions such as assisting teaching, assisting learning, and intelligent pushing. These technological innovations are not only able to address the limitations of traditional teaching materials, but more importantly, provide the possibility of personalized training for the innovation of education model. Therefore, personalized teaching materials in colleges and universities need to integrate multimedia technology, interactive functions and artificial intelligence and other innovative elements to build a new type of teaching material system that includes professional knowledge packages and digital resource libraries.

2.4. The Necessity of Personalized Teaching Material Construction

Through the analysis of existing literature, the research on the application of artificial intelligence in the field of education presents the characteristics of in-depth technology but insufficient integration. Li Zheng (2025) points out that current research on vocational education teaching materials does not support practical problem solving to a high degree[1]; Xu Guoqing (2024) warns of the phenomenon of deviation from expectations in the development of digitized teaching materials[2]; and Xu Yu et al. (2025) focuses on the ethical risks in the construction of digitized teaching materials[3]. These current statuses of research indicate the shortcomings of current research and also provide important references for the innovative direction of this study.

Based on the above background and status quo, this study intends to explore the construction of a systematic framework for technology-enabled education, which echoes the concept of "carrier-service" proposed by Wu, Yonghe et al[4]. We will also improve the evaluation system of intelligent educational resources to respond to Feng Chaojun et al.'s (2024) call for a quality evaluation mechanism[5]. In parallel with the study, we will carry out the development of personalized teaching materials for the courses of my teaching team to verify the feasibility.

3. AI-enabled Strategies for Personalized Textbook Design

3.1. Dynamic Content Generation Strategies

In the current educational environment, textbook content needs to have the ability to evolve dynamically to adapt to the needs of rapid knowledge updating. Through the analysis of learners' cognitive characteristics, knowledge mastery and learning preferences to form a personalized chemical analysis, support the construction of personalized content generation model. The model should contain three core components: the knowledge extraction module is responsible for identifying key concepts and related relationships from massive educational resources; the difficulty adjustment module automatically adjusts the depth and breadth of the content according to the learner's ability level; and the presentation module determines the content organization that is most suitable for the current learner. In teaching practice, this dynamic generation method can realize a significant improvement in learning efficiency, especially in the more practical areas such as vocational education, where cases and practical training content can be updated in real time according to the latest development of the industry. However, an effective quality control mechanism needs to be established in the content generation process to ensure academic rigor while conforming to the laws of teaching.

3.2. Multimodal Interaction Design Strategy

The interaction design of intelligent teaching materials needs to break through the limitations of traditional paper-based teaching materials and build a multi-dimensional interactive experience, especially in vocational education, which is more strongly demanded to cultivate students' skill literacy. First, the cognitive level of interaction, through the intelligent question and answer system to achieve anytime and anywhere learning support; second, the operational level of interaction, the use of virtual simulation technology to provide close to the real practice environment; and third, the social level of interaction, to support the collaboration and experience sharing between learners. The interaction design of the three levels needs to follow the principle of "progressive guidance", i.e., according to the learner's proficiency level, gradually and progressively open up more complex functions to help students advance from novice to skilled, and then to competent and expert. For example, beginners can prioritize the use of basic knowledge Q&A functions, and then gradually contact case studies, virtual training and other advanced functions as their ability improves. This design idea can not only reduce the cognitive load of beginners, but also provide enough exploration space for advanced learners. The results of the analysis of the learning situation can be used for teaching and learning to achieve personalized training.

3.3. Closed-loop optimization strategy

Continuous optimization of teaching materials is the key to ensuring long-term effectiveness, and personalized teaching materials empowered by AI need to iterate content and technology in a timely manner compared with traditional teaching materials. A complete closed-loop system of "data collection - problem diagnosis - content iteration" should be established: firstly, identify the parts of the teaching materials that need to be improved by recording learners' reading behaviors, test performances and feedback; then adopt incremental updating to prioritize the key problems affecting the learning effect; and finally validate the optimization effect through A/B testing. The closed-loop system should have self-learning capability to continuously improve the optimization efficiency with the accumulation of usage data. The optimization process needs to pay special attention to keeping the core knowledge framework of the textbook unchanged, and only adjusting the specific presentation and auxiliary content to avoid the adaptation difficulties caused by frequent changes. At the same time, teachers should be allowed to retain the authority of manual intervention to ensure the leading position of educators, better grasp the realization of teaching goals, and personalized training in each course.

4. Application Path Design for Technology Integration

4.1. Systematic Development Framework

To realize the in-depth integration of AI technology and textbook design, it is necessary to establish a scientific development process. By analyzing the existing digital teaching material platform, a "three-layer architecture" development model is adopted: the foundation layer focuses on technical support, including data processing, algorithmic models and computational resources, which provides technical support for the realization of accurate analysis of learning conditions and accurate knowledge delivery; the middle layer realizes educational functions, such as knowledge management, learning path planning and effect evaluation, which provides technical support for the supply of teaching resources, teaching process and teaching evaluation; the application layer provides technical support for the supply of teaching resources, teaching process and teaching evaluation; and the application layer provides technical support for the supply of teaching resources, teaching process and evaluation. The middle layer realizes educational functions, such as knowledge point management, learning path planning and effect evaluation, and provides technical support for the supply of teaching resources, the teaching process, and teaching evaluation; the application layer faces the end-users, and provides friendly interactive interfaces to provide technical support for the learners and educators to have an efficient and enjoyable experience. The layered architecture is conducive to controlling the development complexity while maintaining the flexibility of the system. During the implementation process, the smallest unit module of a course can be constructed first to verify the feasibility of the core functions, and then gradually expand other modules and courses. The development process maintains close collaboration and timely communication between education experts and technicians to ensure that every technical decision serves the realization of teaching goals. The framework design needs to pay special attention to reserving expansion interfaces to adapt to new technologies and new needs that may arise in the future.

4.2. Key Technology Implementation Path

The choice of knowledge organization technology directly affects the intelligence level of personalized teaching materials. Modern knowledge mapping technology can well express the complex relationship between concepts and provide a structured foundation for personalized learning. In the construction process, a hybrid approach of "developer definition + automatic extraction" can be adopted: first, the developer defines the general framework of the knowledge system, and then extracts the specific associations from teaching resources through natural language processing technology. In terms of content generation, although the large language model performs well, it requires developers to design effective guidance mechanisms and learners to use them to ensure that the generated content meets the teaching requirements. The realization of interactive functions needs to balance immersion and practicality, avoiding the excessive pursuit of cool technology, which inversely affects the learning effect. The choice of all technical routes should be based on the needs of the actual

educational scenarios as a starting point, combined with the actual professional courses, rather than simply pursuing technological sophistication.

4.3. Standardized Implementation Guarantee

Scale application of intelligent personalized teaching materials also requires the establishment of a perfect quality assurance system. Standard specifications can be established in three dimensions: the technical dimension stipulates the data format, interface protocols and other basic requirements; the content dimension ensures the accuracy of knowledge, teaching applicability; the operational dimension standardizes the use of processes and management requirements. And the standard should maintain a moderate degree of flexibility, leaving room for innovation. The process of promoting the use of personalized teaching materials needs to be supported by teacher training to help teachers master the use of intelligent personalized teaching materials and optimization skills, and enhance the teachers' practical ability in technical operation guidance theory and instructional design cases; at the same time, the establishment of a continuous support service mechanism to solve various problems encountered in the process of use in a timely manner is also a concern of the developers because the above safeguards will have a direct impact on the actual application effect and the effectiveness of the personalized teaching materials. The above safeguards will have a direct impact on the actual application effect of personalized teaching materials and the quality effect of personalized teaching materials on the teaching quality of personalized education.

Funding

This study was supported by the "Research on the Implementation Path of Artificial Intelligence-Enabled Personalized Education" (Project No. C/2024/02/53) of the Jiangsu Province Education Science Planning Project.

Disclosure statement

The authors declare no conflict of interest.

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