Vol. 24 (2026): Proceedings of the 2nd International Conference on Linguistics, Psychology and Creative Education (ICLPCE 2026)
E-ISSN: 3105-0522 P-ISSN：3105-0514
DOI: https://doi.org/10.70267/iclpce.20263846

AI-Driven Paradigm Shift in Personalized Learning: Cognitive Reconfiguration and Institutional Adaptation in Higher Education

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Abstract

The deep integration of artificial intelligence (AI) technology with higher education is driving a fundamental transformation in personalized learning paradigms, triggering cognitive reconfiguration among learners and educators within the higher education field, as well as adaptive adjustments at the institutional level. This study comprehensively employs literature review, questionnaire surveys, and qualitative interviews to systematically analyze the current status, positive impacts, and practical challenges of AI applications in personalized learning at universities. The research finds that AI significantly improves learning efficiency and optimizes the allocation of teaching resources, yet it also faces multiple challenges such as data security and the transformation of teachers' roles. Meanwhile, cognitive reconfiguration is manifested in learners' restructuring of knowledge authority, learning processes, and human-machine relationships, as well as educators' updated perceptions of teaching roles, educational technology, and talent cultivation goals. Based on these findings, promoting the paradigm shift of personalized learning requires systematic institutional adaptation in terms of technical specifications, faculty development, and resource allocation, providing theoretical support and practical pathways for AI-empowered higher education.

Keywords

artificial intelligence, higher education, personalized learning, cognitive reconfiguration, institutional adaptation

1. Introduction

In the context of the deep integration of digital technology and education, personalized education has become the core direction for high-quality development in higher education, while artificial intelligence technology provides technical support and practical pathways for the implementation of personalized learning. UNESCO defines personalized education as a learner-centered approach that fully considers learners' prior knowledge, personal needs, and ability differences, emphasizing the central role of individual differences in educational design [1]. Meanwhile, the *New Generation Artificial Intelligence Development Plan* issued in 2017 elevated AI development to a national strategy, explicitly calling for the strengthened application of AI in education. In 2024, the Ministry of Education launched an AI-empowered education initiative, introducing specific measures such as AI learning columns to promote deep integration of AI with education and teaching

[2]. Universities are currently exploring AI applications in personalized learning path design, teaching resource integration, intelligent tutoring and Q&A, and learning assessment and feedback. Some universities have achieved personalized adaptation of teaching content through intelligent course recommendation systems and adaptive learning platforms [3]. However, AI applications in higher education personalized learning are still at an early stage, facing problems such as insufficient integration of technical applications with educational principles, lagging cognitive adaptation of teachers and students, and incomplete institutional support systems. In this context, exploring the paradigm shift of personalized learning in higher education driven by AI, and analyzing the laws of cognitive reconfiguration and pathways of institutional adaptation within the field, has significant theoretical and practical implications.

This study aims to address the core issues of AI-driven personalized learning transformation in higher education from both theoretical and practical perspectives. Theoretically, it incorporates cognitive reconfiguration and institutional adaptation into the analytical framework for AI and higher education integration, enriching relevant theoretical research and revealing the evolutionary patterns of cognitive modes and institutional structures in higher education under technological change, which provides a new perspective for understanding the paradigm shift in higher education [4]. Practically, first-hand empirical data offers practical evidence for universities to optimize application modes of AI-enabled personalized education. The institutional adaptation strategies proposed can also serve as a reference for educational authorities to formulate AI education policies and improve institutional support systems, facilitating the effective implementation of AI technologies in higher education and promoting educational equity and teaching quality [5]. This study adopts multiple combined research methods. It firstly uses a literature review to systematically sort out domestic and international policy documents, academic papers and practical cases on artificial intelligence, personalized education and higher education reform, clarifying research progress and theoretical foundations [6]. A total of 1,000 questionnaires are distributed to university students in Zhejiang Province covering multiple dimensions and disciplines. Semi-structured interviews are conducted with frontline teachers and educational administrators to explore practical difficulties, role transformation challenges and institutional needs. Mixed methods are applied to cross-analyze quantitative and qualitative data, with diversified survey and interview participants ensuring research representativeness.

2. Theoretical Foundations and Current Application Status of AI-Driven Personalized Learning in Higher Education

2.1 Definition of Core Concepts

This study involves three core concepts that need to be clarified. The first is AI-driven personalized learning, a learning model that uses AI technology as its core support, employing technical means such as big data analysis and intelligent algorithms to accurately identify learners' needs, learning styles, and levels of knowledge mastery. It customizes personalized learning paths for learners, recommends appropriate teaching resources, and enables real-time monitoring, assessment, and feedback of the learning process. The second is cognitive reconfiguration, which refers to the process in which, against the backdrop of AI technology being integrated into higher education teaching processes, the cognitive systems of learners and educators are disrupted, leading to the formation of new cognitive structures around aspects such as knowledge authority and the learning process. It represents the subject's cognitive adaptation and restructuring in response to technological change. The third is institutional adaptation, which is the process by which higher education institutions adjust, improve, and innovate existing educational management systems, teaching evaluation systems, and other related mechanisms to adapt to the paradigm shift brought about by AI-driven personalized learning. It is the adaptive response of the institutional system to technological change.

2.2 Application Scenarios of AI in Personalized Learning at Universities

AI technology has gradually penetrated various aspects of personalized learning in higher education, forming diverse application scenarios. Personalized learning path design uses intelligent diagnosis and assessment systems to accurately analyze students' knowledge weaknesses and learning needs, customize personalized learning plans, and rely on campus smart education systems to achieve intelligent course selection and dynamic adjustment of learning progress. Teaching resource integration and recommendation adopts an AI+discipline model to promote cross-disciplinary resource integration. Through AI algorithms, it

recommends STEAM education and PBL project-based learning resources that match students' interests and abilities, achieving precise matching and optimal allocation of teaching resources. Intelligent tutoring and Q&A use generative AI learning tools and multiple intelligent learning apps to provide personalized tutoring to students. By analyzing student learning data, it accurately identifies learning problems and dynamically adjusts tutoring content and methods. Learning assessment and feedback uses intelligent evaluation and feedback systems to comprehensively assess students from multiple dimensions such as knowledge mastery, skill application, innovation ability, and teamwork, providing targeted improvement suggestions [7].

2.3 International Experiences in AI-Driven Personalized Learning

Many international practices in AI-driven personalized learning in higher education provide useful references for China. The *Quality Compass* published by the UK's Quality Assurance Agency for Higher Education emphasizes that universities should redesign curriculum systems to cultivate students' critical thinking and problem-solving skills to meet talent needs in the AI era [8]. Australia's *Framework for the Use of Generative AI in Schools* clarifies core principles such as privacy protection, data security, and transparency, providing institutional norms for AI education applications [9]. The Redford International School in the United States has introduced an advanced intelligent education platform that customizes personalized learning plans for students through intelligent algorithms, achieving dual improvements in learning efficiency and outcomes [10].

3. Empirical Analysis of AI-Driven Personalized Learning in Higher Education

3.1 Basic Characteristics of Survey Respondents

This survey targeted undergraduate and graduate students from multiple universities in Zhejiang Province, covering various disciplines such as humanities and arts, social sciences, natural sciences, and engineering technology, while also considering different grades and genders to ensure sample representativeness and coverage. A total of 1,000 questionnaires were distributed, and after validity screening, 892 valid questionnaires were returned (effective response rate 89.2%), providing good statistical value. The demographic characteristics of the valid sample are as follows: In terms of gender, 412 males (46.2%) and 480 females (53.8%), showing a relatively balanced gender distribution. In terms of grade, 215 freshmen (24.1%), 238 sophomores (26.7%), 207 juniors (23.2%), 156 seniors (17.5%), and 76 graduate students (8.5%), covering all undergraduate years and graduate level. In terms of discipline, 58 from humanities and arts (6.5%), 330 from social sciences (37.0%), 189 from natural sciences (21.2%), and 315 from engineering technology (35.3%). The proportions across disciplines are reasonable and can reflect the current status of AI tool usage among students from different majors. Overall, the survey sample is balanced in terms of gender, grade, and discipline, and the data results can effectively reflect the overall situation of AI tool-assisted learning among university students in Zhejiang Province.

3.2 Basic Analysis of AI Tool Usage

This survey analyzes university students' basic usage of AI tools from three dimensions: frequency of use, types of use, and scenarios of use. The relevant statistical data are presented in Table 1.

Table 1: The basic usage of AI tools.

Dimension	Category	Number (persons)	Percentage (%)
Frequency of Use	Daily use	186	20.8
	Several times per week	425	47.6
	Several times per month	168	18.8
	Occasional use	93	10.4
	Never used	20	2.2
Type of Use	Generative text tools	699	78.5
	Intelligent learning platforms	581	65.2
	Professional domain tools	291	32.6
Scenario of Use	Course learning / homework	734	82.3
	Information retrieval	674	75.6
	Thesis writing / research	551	61.8

As can be seen from the statistical table, over 85% of university students have used AI tools to assist learning, indicating a high penetration rate of AI applications in university student learning. The usage of tools shows clear type preferences and scenario focus. Generative text tools are the core choice due to their ease of operation, and usage scenarios are highly concentrated in formal learning activities such as course learning and information retrieval, with the core demand being assistance in completing routine learning tasks.

3.3 Students' Perceptions and Evaluations of AI Tool-Assisted Learning

3.3.1 Perceived Usefulness

81.5% of students agreed that using AI helps them complete learning tasks faster; 76.8% believed that using AI improves the quality of their learning or assignments; 79.2% indicated that using AI enhances learning efficiency; 80.1% felt that AI is very helpful for learning. The vast majority of students recognize the practical value of AI tools in assisting learning, believing that they effectively improve learning efficiency and quality [11].

3.3.2 Perceived Ease of Use

72.3% of students found it relatively easy to learn how to interact with AI; 75.6% indicated that AI tools are flexible and easy to interact with; 78.9% agreed that AI tools are generally easy to use. The current mainstream AI tools' interfaces and interaction methods align with students' usage habits, providing high ease of use and lowering the barrier to entry.

3.3.3 External Environment and Usage Motivation

65.2% of students indicated that important people around them think they should use AI; 58.7% believed that the atmosphere of their department or university encourages AI-assisted learning; 70.3% said that media coverage of AI enhances their willingness to use it; 62.8% felt they can easily access AI tools. However, only 45.6% indicated they know where to get help when encountering difficulties with AI. The overall external environment for students using AI tools is favorable, but universities' guidance and support systems for AI use are still inadequate. 68.5% of students found the process of using AI tools enjoyable; 71.2% said using AI tools is interesting; 65.8% felt that using AI tools brings novelty and excitement. The fun and innovative nature of AI tools is an important motivator for student use, effectively stimulating learning interest.

3.3.4 Information Accuracy and Satisfaction

52.3% of students believed that the information or answers provided by AI tools are reliable; 48.6% trusted the accuracy of AI-generated content; 78.9% worried that AI might produce hallucinations or provide incorrect information. Students have certain doubts about the accuracy of AI-generated content, with information distortion being a major concern. 70.5% of students were satisfied with their learning experience using AI tools; 68.2% felt that learning with AI tools met or exceeded expectations; 65.8% were satisfied with the functionality of current mainstream AI tools. Overall, students have relatively high satisfaction with AI tool-assisted learning, though there is room for improvement.

3.3.5 Continuous Usage Intention

75.6% of students indicated that they intend to continue using AI tools frequently in the future; 78.2% said they would recommend AI tools to classmates or friends; 72.8% expressed a tendency to use AI as a long-term learning aid. Given the perceived usefulness and satisfaction data, students show strong continuous usage intention for AI tools, suggesting that AI is likely to become a regular auxiliary tool for university students' learning.

3.4 Students' Concerns and Suggestions for Improvement Regarding AI Tools

Students' concerns about using AI tools include data security and privacy protection, academic integrity, information accuracy, and over-reliance. Specifically, 76.5% of students worried about personal learning data leakage; 72.3% believed that AI tools may encourage plagiarism and ghostwriting; 78.9% worried that AI-generated incorrect information might affect their learning; 65.2% worried that long-term use of AI might reduce their independent thinking ability. Students' suggestions for improving AI tool-assisted learning include: optimizing personalized learning path design to improve the accuracy of learning resource

recommendations; strengthening data security and privacy protection by regulating AI data collection and use; improving the accuracy of AI-generated content to reduce hallucinations; enhancing intelligent tutoring and Q&A functions to increase the professionalism and specificity of problem-solving; and strengthening university guidance on AI use to cultivate students' AI literacy and independent thinking ability.

3.5 Key Findings from Interviews with Teachers and Administrators

This study conducted semi-structured interviews with 15 frontline university teachers and 10 educational administrators. The interview results complement the student survey data, further substantiating the practical problems and development demands of AI applications in personalized learning in higher education. Interviewees generally agreed that although AI technology can effectively reduce teachers' repetitive workload (e.g., grading assignments, analyzing learning situations) and improve teaching efficiency, its application remains at a superficial level. In deeper teaching scenarios such as personalized course design and cross-disciplinary resource integration, problems include low compatibility between tools and professional teaching, and insufficient teacher application competence. At the same time, there is a clear capability stratification among teachers. Those with longer teaching experience face difficulties in operating and integrating AI tools, and some teachers have psychological resistance. Universities also lack a stratified, categorized training system for AI teaching competence and supporting incentive mechanisms. Educational administrators highlighted issues of unbalanced resource allocation and lack of institutional guarantees in AI education applications. The gap in AI resource investment between universities and between disciplines is significant, with a clear bias toward science and engineering. Most universities have not yet perfected relevant systems for data security protection, AI tool usage norms, and academic integrity supervision, making it difficult to address the new challenges brought by AI applications. Teachers and students on campus also lack professional technical support and guidance in using AI tools.

4. Opportunities and Challenges of AI-Driven Personalized Learning in Higher Education

4.1 Positive Impacts of AI-Driven Personalized Learning

Based on questionnaire data and qualitative interview materials, AI applications in personalized learning at universities demonstrate significant positive impacts. First, this model enables personalized learning and precise tutoring. AI technology accurately identifies students' learning needs and weaknesses, customizes personalized learning paths, and provides one-on-one intelligent tutoring. Over 80% of students recognize the role of AI tools in improving learning efficiency and optimizing learning outcomes. Second, AI technology assists teachers in improving teaching efficiency. AI can replace teachers in completing repetitive tasks such as grading assignments and analyzing learning situations, allowing teachers to devote more energy to course design, personalized guidance, and student ability cultivation. In interviews, teachers generally indicated that AI effectively reduces their teaching workload and significantly enhances teaching efficiency and targeting [12]. Third, this model provides opportunities for cross-disciplinary and practical learning. AI technology integrates cross-disciplinary resources and recommends PBL project-based learning resources that match students' interests and abilities, aligning with the talent cultivation requirements of higher education in the new era. Finally, AI can promote educational equity and balanced resource allocation. AI technology digitizes and intelligently disseminates high-quality educational resources, enabling all students to conveniently access them, narrowing resource gaps between universities and disciplines, and providing a technical pathway for achieving educational equity.

4.2 Practical Challenges of AI-Driven Personalized Learning

Despite the significant advantages of AI in personalized learning at universities, the research finds that its application still faces multiple practical challenges, which align closely with students' concerns in the questionnaire and are corroborated by teachers and administrators in interviews. Data security and privacy protection are prominent issues. Universities lack effective protection mechanisms for AI data collection, storage, and usage, putting students' personal learning data at risk of leakage. This is the primary challenge for AI education applications [13]. Teachers' role transformation and adaptation are quite difficult. AI is driving a shift in teachers' roles from knowledge imparters to learning guides, but some teachers lack information technology literacy, making it difficult to use AI teaching tools proficiently. Some teachers even

resist AI technology, making it hard to adapt to role changes. Academic integrity and student ability cultivation are contradictory. AI tools, due to their convenience, have become tools for plagiarism and ghostwriting. Some students over-rely on AI tools, leading to a decline in independent thinking, innovation, and writing abilities. Uneven technology investment and resource allocation are evident. AI education applications require certain technological investments and hardware support. There is a large gap in information technology construction between different universities, with local and private universities relatively underinvested. Meanwhile, within universities, AI education resources are also distributed unevenly, with science and engineering often receiving far more resources than the humanities and social sciences.

5. Cognitive Reconfiguration in AI-Driven Personalized Learning

5.1 Learners' Cognitive Reconfiguration

As the core subjects of AI-driven personalized learning, university students' cognitive reconfiguration is first manifested in the restructuring of knowledge authority. In traditional learning, teachers are the absolute authority on knowledge, and students mainly acquire knowledge through teachers' lectures. In the AI era, knowledge sources expand to a pluralistic authority consisting of both teachers and AI, enabling students to develop new understandings of how to acquire knowledge. Second is the cognitive shift in the learning process. Traditional learning is characterized mainly by passive reception, whereas AI-driven personalized learning emphasizes active construction. Students can customize learning paths according to their own needs and autonomously control their learning pace, significantly enhancing their sense of agency [14]. The cognitive update of human-machine relationships is equally important. Students' perception of AI tools shifts from auxiliary tools to learning partners. Over 70% of students use AI as a long-term learning aid, gradually establishing a cognitive framework of human-machine collaboration. However, some students also exhibit cognitive biases, such as over-reliance on AI tools and neglect of their own ability development, which need to be corrected through university guidance and education.

5.2 Educators' Cognitive Reconfiguration and Role Transformation

University teachers and educational administrators are the guides and promoters of AI-driven personalized learning, and their cognitive reconfiguration manifests in several aspects. Restructuring of teaching roles leads teachers to shift from knowledge imparters to learning guides, focusing more on cultivating students' abilities and addressing individual needs. The core of teaching work shifts from teaching knowledge to teaching methods. Second, improvement in perceptions of educational technology leads teachers from unfamiliarity and resistance to acceptance and application. More and more teachers are actively learning how to use AI teaching tools and integrating AI into all aspects of teaching. Meanwhile, updating talent cultivation goals means teachers no longer solely emphasize knowledge mastery, but focus more on core competencies such as critical thinking, innovation ability, and digital literacy, enabling students to adapt to social development in the AI era and meet contemporary needs [15]. It is worth noting that teachers' cognitive reconfiguration focuses more on optimizing soft environments such as teaching methods and classroom organization, complementing students' cognitive tendencies that focus on hard conditions such as technical performance and resource availability. Their synergy needs to be achieved through institutional design.

6. Institutional Adaptation Pathways for AI-Driven Personalized Learning

6.1 Improving Technical Application Norms

Building a strong defense line for data security and privacy protection is the primary task. Data security and privacy protection are prerequisites for AI education applications. Universities need to establish and improve technical norms and institutional systems for AI education applications, strengthening management across the entire process of data collection, storage, usage, and disposal. This includes developing management systems for AI data collection and use, clarifying the scope, purpose, and methods of data collection, and adhering to the principle of minimum necessity; strengthening technical protection for data security, building secure big data platforms, and using technical means such as encryption and desensitization to protect students' personal learning data; establishing a data security supervision mechanism and setting up specialized

information technology supervision departments to conduct regular supervision of data usage in AI education applications; and improving relevant accountability mechanisms, clarifying the responsible entities for data security, and seriously pursuing accountability for data leakage, misuse, and other behaviors to protect students' legitimate rights and interests.

6.2 Strengthening Faculty Development

Improving teachers' information technology literacy and role adaptation ability is a key link. Teachers' information technology literacy and role adaptation ability are critical for the implementation of AI-driven personalized learning. Universities need to strengthen faculty development to promote teachers' cognitive reconfiguration and role transformation. This includes building a stratified, categorized AI teacher training system, providing personalized training on AI teaching tool usage and educational philosophy updates for teachers of different disciplines and teaching experience levels to enhance their information technology literacy and AI teaching application competence; establishing an AI teaching practice exchange platform, organizing activities such as AI teaching demonstration classes and seminars to share AI teaching practices, promoting mutual learning and progress among teachers; improving teacher assessment and incentive mechanisms, incorporating AI education applications into teaching assessments and promotion systems, and giving recognition and rewards to teachers who actively explore AI teaching applications; and assigning full-time technical support personnel for AI education to provide technical guidance and services for teachers' AI teaching applications, addressing the technical problems teachers encounter during use [16].

6.3 Improving the Academic Integrity System

Balancing AI tool use and student ability cultivation is an important issue. In response to academic integrity problems caused by AI applications, universities need to improve the academic integrity system to balance AI tool use and student ability cultivation. This includes improving academic integrity management systems, clarifying norms for AI tool use in learning and research, defining standards for identifying academic misconduct, and seriously handling academic misconduct such as using AI tools for plagiarism and ghostwriting; strengthening students' academic integrity education and AI literacy cultivation, incorporating both into freshman orientation and general education curricula to guide students to correctly understand the value of AI tools; establishing supervision and detection mechanisms for AI tool use, using technical means such as anti-plagiarism systems and AI content detection tools to inspect students' assignments and theses, promptly identifying and correcting academic misconduct; and innovating teaching models and assessment methods, adopting diversified assessment methods such as process-based assessment and practical assessment, focusing on evaluating students' learning processes and practical abilities, guiding students to use AI tools appropriately, and enhancing their comprehensive abilities.

6.4 Optimizing Technology Investment and Resource Allocation

Promoting educational equity and balanced development is the basic direction. In response to the uneven technology investment and resource allocation in AI education applications, educational administration departments and universities need to optimize resource allocation to promote balanced development of AI education applications. This includes increasing information technology construction investment in local and private universities, establishing special funds for AI education applications, equipping them with necessary hardware and software resources, and narrowing the information technology construction gap between universities; promoting balanced allocation of AI education resources within universities, taking into account the development needs of both science and engineering and humanities and social sciences, and designing personalized AI application models according to the characteristics of different disciplines; building regionally shared AI education resource platforms, integrating high-quality educational resources within regions to achieve interconnection and sharing; and encouraging cooperation between universities and technology enterprises, relying on enterprises' technical and resource advantages to jointly develop AI teaching tools and platforms suitable for personalized learning in universities, reducing the cost of technology investment for universities and improving the level of AI education applications.

6.5 Innovating the Teaching Evaluation System

Adapting to AI-driven personalized learning is a key focus of reform. Traditional teaching evaluation systems, centered on knowledge mastery, are difficult to adapt to AI-driven personalized learning models. Universities need to innovate the teaching evaluation system and establish diversified teaching evaluation mechanisms. This includes transforming evaluation philosophy from a knowledge-based to a competency-based orientation, incorporating students' innovation ability, cross-disciplinary thinking, etc., into the evaluation system to comprehensively assess students' comprehensive abilities; enriching evaluation subjects and methods, building a multiple-subject evaluation system of teacher+AI+student, and adopting a combination of process-based, formative, and summative evaluation methods to comprehensively assess students' learning processes and outcomes [17]; using AI technology to optimize the evaluation process, using intelligent evaluation and feedback systems to collect and analyze student learning data in real time, providing targeted feedback and suggestions for improvement to students, and enhancing the precision and effectiveness of evaluation; and improving the teaching evaluation system for teachers, incorporating personalized teaching and AI teaching applications into teacher teaching evaluations, guiding teachers to actively explore AI-driven personalized teaching models and improve teaching quality.

7. Conclusion

AI technology has been widely applied to various aspects of personalized learning in universities, demonstrating significant advantages in enabling precise tutoring, assisting teachers in improving teaching efficiency, and providing cross-disciplinary learning opportunities. However, it also faces multiple practical challenges such as data security and privacy protection, teacher role transformation and adaptation, and academic integrity. AI-driven personalized learning triggers cognitive reconfiguration within the higher education field. Learners' cognitive reconfiguration is manifested in the restructuring of knowledge authority, learning processes, and human-machine relationships, while educators' cognitive reconfiguration is manifested in updated perceptions of teaching roles, educational technology, and talent cultivation. Cognitive reconfiguration is the psychological and cultural foundation for the paradigm shift in personalized learning, while institutional adaptation is the structural guarantee for the AI-driven paradigm shift. Higher education needs to carry out systematic adaptation in terms of improving technical application norms, strengthening faculty development, improving the academic integrity system, and optimizing technology investment and resource allocation, in order to effectively address the practical challenges of AI applications and realize the paradigm shift in personalized learning.

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Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

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