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Generative Artificial Intelligence Empowering Personalized Learning: Practical Strategies

Bo Chen*
Office of Education Informatization Promotion, Chengdu Normal University, Chengdu 611130, Sichuan, China

**Author to whom correspondence should be addressed.*

Abstract: The rapid development of generative artificial intelligence (GenAI) is leading the education sector into a new transformative stage. Ubiquitous intelligent learning spaces, human-machine collaborative educational scenarios, technology-driven shifts in teaching models, transformations in learning methods, and technology-enabled reform of teaching assessment constitute the foundational conditions for GenAI to empower personalized learning. Data-supported precision teaching, human-machine collaborative personalized learning, and system-integrated intelligent assessment form the practical strategies for GenAI to empower personalized learning. GenAI promotes the reform of consistency in teaching, learning, and assessment, becoming a key driving force facilitating personalized learning.

Keywords: Generative Artificial Intelligence (GenAI); Personalized Learning; Practical Strategies

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1. Introduction

Generative artificial intelligence, represented by models like ChatGPT and DeepSeek, has become the focal point of current educational transformation. GenAI aims to utilize artificial intelligence technology to automatically generate multimodal data such as text, images, videos, and audio, demonstrating exceptional capabilities in multimodal information understanding, knowledge reasoning, and content generation[1]. Currently, school education in China is still predominantly based on collective teaching within the class teaching system, characterized by high demands for examination preparation and advancement, large class sizes, and heavy student academic burdens[2]. The fundamental contradiction between large-scale educational coverage and meeting personalized needs remains prominent[3]. Resolving the contradiction between educational scale and personalization is a major task for educational reform and development in the intelligent era[4]. With the deep integration of AI technology and education, the traditional "teacher-student" dual structure is shifting towards a "teacher-student-machine" ternary structure, advancing the transformation of the existing intelligent educational application ecosystem[5]. Artificial intelligence has become key to achieving the organic integration of large-scale education and personalized cultivation[6]. This article aims to systematically elucidate the foundational safeguards and practical strategies for GenAI empowering personalized learning, exploring methodical pathways for achieving consistency in teaching, learning, and assessment based on GenAI support.

2. Foundational Conditions

2.1. Intelligent Learning Spaces

Currently, all primary and secondary schools in China have internet access, and multimedia classrooms are widely available, laying a solid foundation for constructing ubiquitous intelligent learning spaces. Generative artificial intelligence is guiding the transformation of learning spaces towards intelligent conversational learning spaces[7]. Intelligent learning spaces integrate cutting-edge technologies such as 5G, AI, XR (VR/AR/MR), and digital twins, exhibiting significant characteristics of personalization, precision, strong interactivity, and high flexibility.

Personalization is reflected in the ability to provide precise learning plans and personalized learning resources tailored to each student's needs.

Precision manifests through learning data analysis technology, enabling accurate teaching and feedback to enhance instructional pertinence and effectiveness.

Strong Interactivity is evident as rich online interactive tools offer students diverse interaction methods, effectively enhancing their sense of participation.

High Flexibility means breaking the temporal and spatial constraints of traditional education, effectively supporting students in flexible learning at their own pace and schedule.

2.2. Human-Machine Collaborative Educational Scenarios

From the perspective of classroom teaching scenarios,GenAI can comprehensively empower diverse scenarios such as teaching, learning, assessment, and tutoring, providing targeted support[8]. The developmental progression of human-machine collaborative education is categorized into human-machine cooperation, human-machine augmentation, human-machine integration, and human-machine co-creation[9]. The "teacher-student-machine" ternary collaboration will gradually become the new norm in education. Human-machine collaborative education is primarily manifested in the close cooperation between AI and teachers to accomplish teaching tasks. Educational agents, as engines of innovation in the intelligent era, demonstrate significant application potential and importance in typical educational scenarios such as classroom teaching, educational assessment, and teacher research (e.g., assisting in instructional design, teaching management, and teaching evaluation), thereby effectively enhancing teaching efficiency. The core objective is to make AI a natural extension of human intelligence, solving complex educational problems more efficiently through collaboration, and achieving personalized, intelligent, and sustainable education. The key lies in fully integrating the concept of collaboration into all aspects of education and teaching.

2.3. Technology-Driven Transformation of Teaching Models

Regarding classroom teaching models, teaching according to aptitude can be achieved through human-machine collaborative "dialogic learning" and "argumentative learning," providing personalized learning support while cultivating students' higher-order thinking skills[10]. The widespread application of GenAI is prompting the emergence of more diverse, flexible, and efficient teaching models:

Human-Machine Collaborative Interactive Teaching Model: Leverages AI advantages to strengthen teacher-student interaction. Teachers transition to facilitators, students become active participants.

Data-Driven Precision Teaching Model: Based on big data analysis of student learning behaviors, enables real-time, precise diagnosis of learning situations for dynamic adjustment of strategies and content, implementing highly personalized interventions.

Resource-Sharing Blended Teaching Model: Integrates rich online resources (network courses, videos, forums) with offline activities (practical activities, group discussions, lectures), optimizing learning experience and outcomes.

Virtual Simulation Inquiry-Based Teaching Model: Utilizes virtual simulation technology to create practical environments, supporting student exploration and problem-solving.

2.4. Technology-Promoted Transformation of Learning Methods

The application of AI in classroom teaching provides students with more personalized learning experiences[11]. The construction of intelligent learning support environments gives rise to new learning methods characterized by:

Autonomy and Personalization: Adaptive learning systems provide personalized strategies and progress adjustments based on individual student circumstances (e.g., progress, style), enabling true self-directed learning.

Collaboration and Interactivity: Smart terminal devices (e.g., tablets, interactive whiteboards) provide platforms for real-time collaboration, knowledge sharing, and problem-solving.

Ubiquity and Flexibility: Mobile internet technology enables anytime, anywhere access to resources and interaction, meeting diverse learning needs.

Immersion and Experiential Learning: VR/AR technologies create highly realistic, interactive environments for deep engagement and embodied experiences.

2.5. Technology-Enabled Reform of Teaching Assessment

The rise of AI and big data technologies provides students with precise assessment methods for both high-level cognitive and non-cognitive abilities[12]. GenAI provides key support for teaching assessment innovation:

Formative and Timely Feedback: AI and big data enable instant collection and analysis of teaching process data, providing teachers with precise progress and competency evaluations for dynamic strategy adjustment.

Intelligent Assessment Implementation: Automated tools efficiently evaluate academic levels across multiple dimensions (e.g., exams, homework, participation), providing immediate, specific feedback.

Multimodal Comprehensive Evaluation: Integrates and analyzes multidimensional data (e.g., exams, performance, collaboration, innovation) using technologies like Learning Management Systems (LMS) for objective, systematic evaluation of core competencies and holistic development.

3. Practical Strategies

3.1. Data-Supported Precision Teaching

Data-driven precision teaching aims to use data as the foundation to drive the realization of “precision teaching” and “personalized learning”[13]. This is specifically reflected in:

Precise Learning Diagnosis and Adaptive Teaching: Intelligent systems comprehensively collect and analyze multidimensional student data to diagnose learning status in real-time, quickly identify difficulties, conduct adaptive teaching, design personalized learning paths, provide personalized diagnostics, prompts, and feedback to support individualized learning[14].

Dynamic Guidance and Process Intervention: Teachers, aided by real-time learning data (progress, difficulties), conduct timely, targeted tutoring and intervention, ensuring teaching strategies remain synchronized with student needs.

Intelligent Feedback and Evaluation: Systems provide instant scoring and detailed feedback on student performance (e.g., answers), aiding timely adjustment. Deep analysis of learning process data supports teacher optimization of strategies.

3.2. Human-Machine Collaborative Personalized Learning

AI can continuously track student learning trajectories and perceive learning states in real-time based on multidimensional data[15]. Human-machine interaction, as the cornerstone, brings multifaceted changes to personalized learning:

Personalized Resource Recommendation and Plan Customization: Big data analytics enables the creation of tailored learning paths and resources based on student abilities, interests, and progress.

Massive Resource Supply and Ubiquitous Learning: Smart technology integrates diverse resources (online courses, e-books, videos), enabling anytime, anywhere learning via platforms and mobile apps.

Immersive Experience Construction: VR/AR technologies create safe, realistic practice environments (e.g., virtual labs) fostering practical skills and problem-solving abilities.

3.3. System-Integrated Intelligent Assessment

Utilizing AI's technical characteristics for personalized intelligent analysis is more conducive to teacher self-reflection and transformation, achieving "assessment for teaching improvement"[16]. Intelligent technology shifts assessment from solely testing knowledge/skills towards focusing on core competencies and holistic development:

Comprehensive Formative Monitoring and Analysis: Big data and AI track learning process data across multiple dimensions (time, content, interaction, outcomes) for accurate assessment of ability, potential, and overall performance.

Predictive Intervention and Development Guidance: Machine learning analysis of behavior patterns enables systems to predict potential difficulties or development directions, providing timely personalized suggestions and interventions.

Support for Autonomous Development and Ubiquitous Assessment: Combined online platforms and assessment systems support students in autonomously adjusting learning direction, content, and pace based on feedback, fostering self-directed learning and management skills.

4. Conclusion

The education sector is progressively building ubiquitous intelligent learning spaces, deepening human-machine collaboration in educational scenarios, driving the diversified reconstruction of teaching models, realizing the transformation of learning methods towards personalization and ubiquity, and reforming teaching assessment towards core competencies, process orientation, comprehensiveness, and intelligence. GenAI, deeply integrated throughout the teaching process, becomes the core driving force for realizing student personalized learning. Looking ahead, human-machine collaborative teaching will become more prevalent. Deepening the integration of intelligent technologies, represented by GenAI, with education and teaching, fully activating the potential of data elements, effectively utilizing digital platform tools, continuously improving the digital literacy of teachers and students, and innovating talent cultivation models are key pathways to achieving educational digital transformation and intelligent upgrading, promoting personalized student learning, and driving high-quality educational development. The integrated application of GenAI and education will contribute to realizing the educational vision of teaching according to aptitude. Educators, technology developers, and all sectors of society need to work together, actively explore innovation, propel education to new heights empowered by intelligent technology, and provide a solid guarantee for cultivating high-quality talents who can meet the needs of future societal development.

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