

# *Analysis and Reflection on the Teaching Application of Artificial Intelligence Technology in the Context of Big Data*

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**Abstract:** With the rapid development of big data and artificial intelligence (AI) technologies, the education community is actively exploring new paths to incorporate them into teaching and learning. This paper firstly dissects the potential benefits of these technologies in teaching and learning, and then briefly introduces their applications, such as personalized teaching, teaching decision support, student assessment, resource optimization and innovative teaching. A comprehensive analysis of the specific processes and implementation measures based on AI technologies in personalized teaching is provided. Subsequently, the challenges encountered in AI-based teaching applications, such as data privacy, teacher role evolution, resource allocation and modelling accuracy, are explored, and corresponding solution strategies and recommendations are proposed. Ultimately, the study will serve as a practical guide for educators and policy makers to promote educational innovation and progress in the field of big data and AI-enhanced teaching.

## 1. Introduction

In recent years, the revolutionary wave of artificial intelligence (AI) technology has spread and swept across the entire world. As the forefront of modern information technology development, AI technology has significantly impacted various aspects of production and daily life, propelling global economic growth and signalling the advent of the fourth industrial revolution. AI technology constitutes a set of techniques designed to simulate human intelligent behaviours, including machine learning, deep learning, natural language processing, and computer vision, among others. Based on these means, AI technology is capable of enabling computer systems to perform tasks similar to human intelligence, so the widespread application of AI technology has become a hot topic in all areas of society. From the smart home [1] to the financial field [2], from smart manufacturing [3] to agriculture [4], from intelligent transportation [5] to medicine [6], AI technology has shown great potential and market value.

In the congratulatory letter to the International Conference on Artificial Intelligence and Education, the president of China pointed out that "we should actively promote the deep integration

of AI and education, promote educational transformation and innovation, make full use of the advantages of AI, and accelerate the development of education that accompanies everyone throughout life, is equally oriented to everyone, is suitable for everyone, and is more open and flexible". To comprehensively advance education innovation and align with China's strategy of rejuvenating the country through science and education, it is imperative to integrate AI technology, driving innovative development and emphasizing its role in talent cultivation. This is essential to meet the growing demand for high-quality professionals for the development of Chinese society. Therefore, an intelligent, personalized, efficient and accurate approach to education and management, using big data and AI, must be explored and implemented in an "artificial intelligence + education" model. That will foster the deep integration and transformation of educational values and facilitating the high-quality advancement of university education in the contemporary era.

With the rapid development of AI technology, we urgently need to study its impact on the future of education in depth, and gradually figure out how to effectively integrate artificial intelligence organically into education. As a result, it will push forward the innovative reform of education in China, explore new teaching methods, build an innovative education system, and give full play to the value of AI technology. In addition, there are the following points of consensus on the current AI technologies in the context of big data. Firstly, AI technology is able to analyse massive amounts of teaching data, identify students' learning characteristics and patterns, provide teachers with personalized teaching advice and support, and effectively improve teaching efficiency and quality. Secondly, AI technology can promote the innovation and change of teaching mode, so that the teaching mode can be changed from "indoctrination" to "exploration", giving full play to students' autonomy and creativity. Thirdly, AI technology has given new impetus to the professional development of teachers and facilitated the continuous improvement of their teaching effectiveness and skills. Fourthly, the application of AI technology also offers new opportunities for achieving educational equity, where educational resources can be better allocated and utilized to reduce the educational gap between urban and rural areas, between schools and between groups.

In conclusion, the application of AI technology in the field of education under the background of big data brings new opportunities for the innovation of teaching mode, the improvement of teaching quality and the realization of educational equity. Educators should fully understand the significance of AI technology in education, actively explore its application methods, and promote the sustainable development of education.

## **2. Application of artificial intelligence technology in education**

To promote the innovation and reform of education and meet the development needs of China's science and education strategy, it is necessary to always adhere to education as the main position of China's talent cultivation, and actively introduce AI technology to promote the process of intelligence, personalization and fairness in education. Continued advances in AI technology have driven innovation in the education field in a variety of areas, including personalized teaching [7], teaching decision support [8], student assessment and monitoring [9], optimization of educational resources [10] and innovations in teaching methods [11].

### **2.1. Personalized teaching**

Personalized teaching is a positive way of education, which can not only improve students' learning interest and motivation, but also stimulate their creativity and thinking ability. The core of personalized teaching is to pay attention to the individual differences of each student in order to promote all-round development of students. By grasping the characteristics of students, and flexibly utilizing diversified teaching strategies and resources, teachers can effectively enhance their ability

to understand and master knowledge. However, collecting and analysing personalized data is a complex process that requires significant time and resources, and the current assessment tools and methods are relatively outdated and cannot effectively support the implementation of personalized teaching. Artificial intelligence technology, with its intelligence, automation and high adaptability, makes up for the shortcomings of personalized data analysis. It can autonomously learn and analyse students' learning data to achieve accurate personalized teaching.

## **2.2. Teaching decision support**

Traditional teaching decision-making cannot reflect the complexity, dynamics and reticence of educational situations and subjects, as well as the differences in the effectiveness of teaching practice, and cannot show the effectiveness of teachers' teaching decision-making process and practice. Artificial intelligence technology, on the other hand, can provide good technical support for teaching decision-making, which can organize, analyse, evaluate, feedback and integrate multi-dimensional data of schools, teachers and students to promote scientific teaching decision-making, improve the overall level of education and enhance the quality of teachers' teaching. For example, adjusting the teaching plan, curriculum, and allocation of teaching resources according to students' learning data will continuously improve the teaching effect of students. Therefore, AI-driven teaching decision making is regarded as an important way to improve teachers' teaching efficiency and promote the progress of school education.

## **2.3. Assessment and monitoring of students**

As an important task within the field of education, assessment and monitoring of student generally consists of two parts, namely learning assessment and learning monitoring. The former can systematically evaluate and analyse students' learning achievements, learning attitudes, learning abilities and other aspects through a variety of forms, such as examinations, assignments, classroom performances and project works. The latter, through regular and systematic tracking and monitoring of students' learning processes and learning outcomes, can identify learning difficulties and problems in a timely manner, and provide teachers with the opportunity to adjust teaching strategies and help students overcome their difficulties. The integration of AI technology can help schools and teachers gain a deeper understanding of students' learning, development and personalized needs, while providing precise support for optimizing teaching strategies and personalized education.

## **2.4. Optimization of educational resources**

Effective management and allocation of resources in the field of education is an effective means of improving the efficiency of resource utilization, upgrading the quality of education and promoting equity in education. This process requires continuous optimization of resources, including the integration and sharing of teachers, classrooms, teaching materials, teaching equipment and other resources, so as to avoid waste and duplication of resources and to improve the efficiency of resource utilization. In addition, the evaluation of educational inputs and benefits is also a key link, in which problems and bottlenecks in the use of resources can be identified and resource allocation strategies adjusted in a timely manner through the establishment of scientific evaluation indicators and an evaluation system. Therefore, the optimization of educational resources in the context of big data requires the support of AI technology, through the management and monitoring of educational resources, to achieve the scientific and refined deployment of resources.

## **2.5. Innovations in teaching methods**

Artificial Intelligence, in conjunction with teaching innovation, has opened up vast new horizons for education. Supported by big data, AI can personalize learning paths and resources, and provide teachers with intelligent tools to assist in managing the classroom, assessing students, designing instruction and adjusting strategies. In addition, it can create virtual lab environments that facilitate hands-on learning and exploration, enhance students' understanding of experiments, improve learning outcomes and ensure safety. In short, the combination of AI and teaching innovation promotes the personalized, intelligent and innovative development of education, providing better learning experiences and opportunities.

## **3. Research on artificial intelligence in personalized teaching**

In today's education field, personalized teaching has become a widely noticed and respected teaching mode. Compared with the traditional "one-size-fits-all" teaching, personalized teaching pays more attention to tailoring teaching to students' needs, taking into full consideration the characteristics and needs of each student, so as to provide them with customized educational services. However, how to effectively implement personalized teaching has always been a major challenge for educators.

### **3.1. Concept of personalized teaching**

Since educators began to focus on the subjectivity of students, the emphasis of teaching has gradually shifted and the importance of personalized teaching has become increased. From the nineteenth century onwards, examples of personalized teaching have emerged. After the 1930s, however, its fervour gradually waned, and it was not until the 1960s and 1970s that it regained widespread attention and became a central area of educational reform.

Before exploring personalized teaching, it is important to clarify how it differs from differentiated teaching and individualized teaching. Individualized teaching is distinguished from personalized instruction by quantitative differences, with a focus on one-on-one teaching designed to respect and support students' individual growth. Differentiated teaching differs from personalized teaching in that it focuses on the teachers' understanding of students' individual differences but does not emphasize the teachers' individualized teaching approach. Thus, personalized teaching is defined. Under the intelligent education environment, teachers analyse students' learning situation based on big data on their learning, and discover each student's personalized learning characteristics, such as motivation, interest, style, personality and strengths. Based on these personalized learning characteristics, students are provided with learning contents and targeted learning paths that meet their own needs, and they are guided to find the learning that really suits them. Ultimately, the goal is to positively develop their personalities and promote the development of their potential.

Research on personalized teaching at home and abroad has experienced a long period of accumulation and precipitation, and both the theoretical level and practical application have been deeply explored. However, in the era of big data, personalized teaching urgently needs the empowerment of artificial intelligence technology to stimulate its new vitality and effectively promote the teaching process.

### **3.2. Data analysis process in personalized teaching**

In today's society, educational data analysis plays a crucial role in personalized teaching. It helps educators to analyse student learning in depth, evaluate the effectiveness of teaching and effectively

support educational decision-making. Among the many methods and tools of educational data analysis, collection and collation of data, descriptive statistical analysis, correlation analysis, cluster analysis, predictive analysis, and data visualization are relatively common and practical. The data analysis process of personalized teaching is illustrated in Figure 1.

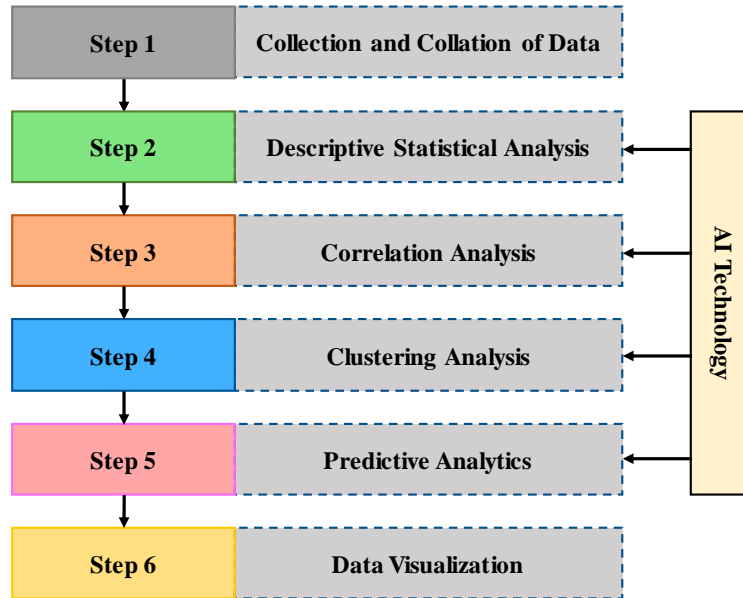


Figure 1: Data analysis process of personalized teaching

**Step 1 Collection and collation of data:** The collection and collation of student learning data is a prerequisite for the implementation of personalized teaching. Under the traditional education conditions, it is difficult for teachers to collect and collate the data due to the limitation of technical means, so personalized teaching is only occasional. With the development of intelligent technology, it is possible to build a new intelligent educational environment and introduce sensory devices, evaluation systems and other means, which can comprehensively collect students' personalized data. This will lead to personalized teaching based on individual learning data gradually becoming a widespread form of teaching. Currently, most university teachers can obtain educational data including learning performance, examination data, attendance data and student behaviour data through school management systems, online learning platforms, questionnaires and other means.

**Step 2 Descriptive Statistical Analysis:** Descriptive statistical analysis plays a key role in educational data analysis. It provides a basic picture of the data by organizing, classifying and summarizing the data, which can reveal the distribution characteristics, concentration trends and degree of dispersion of the data. This method is simple and intuitive. It can quickly grasp the general situation of educational data and lay the foundation for subsequent in-depth analysis.

**Step 3 Correlation analysis:** Correlation analysis can be used to discover relationships between data, such as the relationship between students' academic performance and learning factors (including study time, attendance, students' background, and educational resources). By calculating the correlation coefficient to determine the strength of correlation between variables as well as the trend of positive and negative correlation, we can find the key factors affecting students' performance, so as to formulate targeted teaching and intervention measures.

**Step 4 Clustering analysis:** as an important tool for data mining and pattern recognition, clustering analysis plays an important role in personalized teaching. Through the analysis of multi-dimensional data such as learning performance, learning habits, psychological characteristics, behavioural characteristics, etc., artificial intelligence technology reveals the internal structure of the student group, grasps the characteristics and patterns of students' learning, and divides students

into groups with unique needs to formulate a more scientific, accurate and targeted teaching plan. In addition, clustering analysis can also help teachers discover problems in teaching and adjust teaching strategies in time to continuously improve teaching quality.

**Step 5 Predictive Analytics:** In-depth analysis of collected historical educational data reveals underlying patterns and trends to predict future educational outcomes or behaviours, such as predicting students' academic achievement and graduation rates. This kind of analysis not only helps educators to identify potential problems in advance, but also provides powerful support for optimizing teaching strategies, allocating educational resources, and making school management decisions.

**Step 6 Data Visualization:** In today's data-driven era, the education field is inevitably facing the challenge of data explosion. How to effectively integrate, analyse and present the massive amount of education data into actionable knowledge has become an urgent task for educators. Educational data visualization has become a proven solution that transforms complex data into intuitive charts, graphs, and other forms to help educators better understand the meaning of data, discover hidden patterns and trends, and make more scientific and efficient decisions.

### 3.3. Strategies to improve teaching effectiveness

Primarily, it is crucial to establish a sound mechanism for collecting and analysing comprehensive student learning data. Through the use of various digital teaching tools and AI technologies, such as learning management systems, online testing platforms, machine learning, reinforcement learning, etc., we systematically record and analyse the data on students' learning behaviours, academic performance, classroom performance, etc., so as to understand each student's learning characteristics, knowledge mastery and learning needs. Only with an in-depth understanding of the students' learning situation can teaching strategies be formulated in a targeted manner.

Secondly, develop an adaptive mechanism for tailoring teaching content and methodologies to individual needs. For students with good knowledge mastery, teachers can increase the level of difficulty and broaden the content of the course to stimulate their interest in learning and their desire to explore. For weaker students, more detailed counselling should be taken, focusing on the consolidation of basic knowledge and the cultivation of skills, to help them gradually narrow the gap with other students. Personalized teaching adjustment in the context of big data cannot be separated from the support of AI technology, which can provide students with different learning preferences with personalized learning resources and methods, such as video lectures, online exercises, etc., to enhance the interactivity and fun of learning.

Finally, a sound monitoring and feedback mechanism for teaching quality should be established. Artificial intelligence technology plays an important role in teaching quality monitoring and feedback. Intelligent assessment systems can objectively and comprehensively analyse teaching data and provide a basis for teaching decisions. An AI-powered personalized teaching platform, which collects regular learning feedback of learners and diagnoses their progress at an early stage, can provide targeted guidance and improve the teaching effect. Meanwhile, this platform should also collect teachers' teaching information and encourage teachers to actively explore personalized teaching methods and improve their teaching level. Only through continuous monitoring of the quality of teaching and professional development of teachers can personalized teaching be truly put into practice and play its due role.

Therefore, the realization of AI-driven personalized teaching based on students' learning data requires the joint efforts of schools, teachers and students. Schools should provide teachers with the necessary technical and institutional support, while teachers should continue to learn and innovate,

make full use of data resources, tailor their teaching to students' needs, and improve the effectiveness of teaching. Only in this way can we truly achieve equity in education and develop more well-rounded talents.

## **4. Challenges of artificial intelligence in teaching application**

### **4.1. Data privacy and security concerns**

Artificial intelligence applications in education bring many benefits. However, data privacy and security issues cannot be ignored. Data such as students' personal information, learning behaviors, academic performance and study habits are sensitive and private, which must be properly protected. Educational institutions and technology providers need to adopt data desensitization techniques to anonymize personally identifiable information, and establish strict control mechanisms for data access and usage rights. In addition, to ensure the security and privacy of student data, governments and regulators need to establish appropriate laws and regulatory policies to govern the collection, storage, processing and sharing of data.

### **4.2. Teachers' role change and adaptation challenges**

In traditional education settings, teachers have primarily functioned as knowledge transmitters and classroom managers. However, with the development of AI technology, teachers need to transform into learning facilitators. In order to adapt to the teaching mode of the AI era, this shift in role will require educators to adopt new teaching philosophies and learn new skills. Concurrently, educational policies and teacher training programmes must undergo modifications to support this transition effectively.

### **4.3. Inequitable distribution of technical resources**

Despite AI's substantial potential to revolutionize education, the inequitable distribution of technical resources poses a risk of deepening existing educational disparities. For instance, affluent schools and students are likely to be early adopters of advanced AI-based teaching tools, while underprivileged schools and students in less developed regions face limited access to AI technology.

### **4.4. Challenges in Achieving Model Precision and Prediction Accuracy**

The paramount importance of accurate and reliable instructional models lies in their ability to facilitate effective learning. To achieve this, extensive inquiry into data quality, diversity, dynamism, real-time characteristics, interpretability, and transparency is indispensable. Overcoming these challenges will result in precise learning predictions and tailored learning pathways, ultimately boosting student academic performance.

### **4.5. Over-reliance on AI technologies**

Although AI plays an important role in teaching application, educators need to be aware that technology serves as a facilitator rather than a substitute for human interaction and learning. Over-reliance on AI technology may undermine the active role of educators and hinder students' independent learning capacity. Therefore, a balanced approach is required, integrating AI technology with teachers' and students' participation in the teaching process.

## 5. Conclusions

In the development process of China's education, the active integration of AI technology is a key initiative. It is crucial to acknowledge that the integration of AI technology in education, within the backdrop of big data, presents both substantial opportunities and formidable challenges that warrant in-depth examination. Only by fully recognizing the value of AI technology in teaching in colleges and universities, constantly improving its application mode, and organically combining it with other factors such as educational concepts and teaching methods, can we maximize the value of the application of AI technology in teaching and promote the innovative development of education. In addition, only by continuously improving relevant systems and standards can we better promote the application of AI technology and realize the common development of technology and society.

Based on the present and looking to the future, the application of AI technology in teaching will certainly have a broader development prospect. With the continuous advancement of big data technology and AI algorithms, the application of AI in teaching will be more intelligent, personalized and precise, providing students with a better learning experience. Simultaneously, AI technology will also be deeply integrated with virtual reality, augmented reality and other technologies, injecting new vitality into teaching. Furthermore, the application of AI technology in teaching management, teacher training, teaching evaluation and other aspects will also be deepened, injecting a strong impetus for the high-quality development of education. Only through continuous development and innovation can we promote the continuous improvement of the teaching and learning applications of AI technology, provide students with more high-quality educational resources, and achieve the sustainable development of education.

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## References

- [1] Xiao, G., Zhenjiang S., Yajing Z., Teng W. (2019) *Review on the Application of Artificial Intelligence in Smart Homes. Smart Cities*, 2, 402-420.
- [2] Yosef, B. (2024) *Artificial Intelligence in Finance: Valuations and Opportunities. Finance Research Letters*, 60, 104851.
- [3] Tao, Y., Jinliang, D., Kyriakos, G.V., S. Joe Qin. (2021) *Guest Editorial: Industrial Artificial Intelligence for Smart Manufacturing. IEEE Transactions on Industrial Informatics*, 17, 8319-8323.
- [4] Oliveira, R.C., Silva, R. D. D. E. (2023) *Artificial Intelligence in Agriculture: Benefits, Challenges, and Trends. Applied Sciences (Switzerland)*, 13, 7405.
- [5] Gangwani, D., Gangwani, P. (2021) *Applications of Machine Learning and Artificial Intelligence in Intelligent Transportation System: A Review. Lecture Notes in Electrical Engineering*, 778, 203-216.
- [6] Andrew C. (2024) *Artificial Intelligence in Medicine. The Ulster medical journal*, 92, 167-169.
- [7] Shanshan, L., Hui W., Liqiao W. (2024) *Research and Practice of Personalized Teaching System of Local Comprehensive University Based on Artificial Intelligence Technology. Applied Mathematics and Nonlinear Sciences*, 9, 20240253.
- [8] Sambit, B., Bogdan C. (2023) *Trustworthiness of Artificial Intelligence: Teaching Factors that Influence AI-Supported Decision Making. Journal of Computing Sciences in Colleges*, 38, 85-94.
- [9] Kujur, A.G.P., Tiwari, R.K., Panday, V. (2023) *Student Performance Monitoring System Using Artificial Intelligence Models. Communications in Computer and Information Science*, 1822, 3-18.
- [10] Majeed, M.G., Hameed, W., Haroon, N.H., Abdul Kadeem, S.R., Salman, H.M., Kadry, S. (2023) *Optimizing Resource Management in Physical Education through Intelligent 5G-Enabled Robotic Systems. Fusion: Practice and Applications*, 13, 162-174.
- [11] Yi Y., Jiasong S., Lu H. (2020) *Artificial Intelligence Teaching Methods in Higher Education. Intelligent Systems and Applications*, 1037, 1044-1053.