

ChatGPT: The New Trend of Smart Education

Jianxin Wang, Hongke Xu*, Yuzheng Zheng, Chaoen Xiao, Lei Zhang, Hanlin Chen, Xin Chen

Beijing Electronic Science and Technology Institute, Beijing 100070, China

*Corresponding author: Hongke Xu, 201720060827@ecut.edu.cn

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Abstract: In response to the limitations of the traditional education and teaching model, this article proposes a smart education model based on ChatGPT. The model actively breaks the constraint of time and space and the design patterns of traditional education, providing smart education services including personalized learning, smart tutoring and evaluation, educational content creation support, and education big data analysis. Through constructing an open and inclusive learning space and creating flexible and diverse educational models, ChatGPT can help to meet students' individuality and overall development, as well as assist teachers in keeping up with the students' learning performance and developmental requirements in real-time. This provides an important basis for optimizing teaching content, offering personalized and accurate cultivation, and planning the development path of students.

Keywords: ChatGPT; Smart education; Personalized learning; Education big data analysis

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1. Introduction

ChatGPT is a chatbot tool developed by OpenAI in the United States. GPT is short for Generative Pre-trained Transformer, which is a pre-trained generative model based on the transformer structure^[1]. ChatGPT uses deep learning technology and self-attention mechanism to automatically encode and generate text, demonstrating human-level performance in multiple natural language processing tasks. Compared with traditional machine learning models, ChatGPT is capable of generating powerful text processing and inference abilities through massive data learning, suitable for natural language generation, dialogue systems, text summarization, information retrieval, and other application scenarios^[2,3]. In addition, ChatGPT also supports zero-shot learning and transfer learning, which can apply existing knowledge and experience to new languages and scenarios without the need for retraining^[4].

Smart education is a teaching mode based on information technology, using big data, artificial intelligence, and cloud computing technologies to achieve deep collaboration, personalization, and differentiation. Its goal is to improve the level and efficiency of educating and teaching, optimize students' learning process, experience, and results, and provide more accurate learning programs and tracking services for students at different levels and disciplines, thereby promoting their overall development and independent innovation. Related literature shows that current major universities in China have invested a lot of effort and resources in research and

practice of smart education ^[5,6].

The smart classroom is an extension of the smart education concept, which uses modern technologies such as the Internet of Things, cloud computing, big data, and artificial intelligence to integrate educational informatization means with teaching content. It intelligently transforms traditional classrooms and provides students with comprehensive and diverse teaching resources and environments, combining information space and physical space ^[7]. The smart classroom includes the smart construction of the teaching knowledge system, teaching management system, teaching platform system, and teaching conditions, promoting the innovation of modern education models and advancing the development of education informatization ^[8].

At the 57th China Higher Education Expo held in August 2022, the Beijing Higher Education Society officially released the group standard “Technical Requirements for the Construction of Smart Classrooms in Higher Education Institutions” (T/BAHE-202001) ^[9]. The standard adheres to the principles of “coordination, intensiveness, greenness, development, openness, sharing, and security,” and designs the overall framework for the Construction of Smart Classrooms in higher education institutions, proposing hardware facilities, software applications, and teaching environment construction standards. It aims to guide universities to build smart learning environments based on information technology, standardize the Construction of Smart Classrooms, promote the deep and extensive application of information technology in teaching, promote the reform of teaching concepts, teaching models, and teaching content, and support the cultivation of high-quality innovative talents in the information age.

On December 30, 2022, the “China Smart Education White Paper - Smart Education Based on the Information Innovation System” jointly written by CIO Times, BDRit, and the Higher Education Information Technology Innovation Application Industry-Education Integration Alliance was officially released at the University Information Technology Innovation and Innovation Education Summit and the founding meeting of the Higher Education Information Technology Innovation Application Industry-Education Integration Alliance. The main contents include the background of educational information innovation, the goals and guiding principles of educational information innovation, the architecture framework of smart education, the technical system of educational information innovation, the transformation of smart education and information innovation, the construction of the higher education information innovation system, implementation methods and guarantee systems of educational information innovation. As one of the core contents of the white paper, the white paper proposes Smart Education Architecture Framework (SEAF), which includes six parts: architecture development method, architecture content framework, smart education business reference model, smart education application reference model, information innovation technology reference model, and information innovation operation reference model. This architecture framework can provide systematic methodological guidance for the digitization and information innovation transformation of educational institutions ^[10].

In early 2023, China’s Ministry of Education released the “Smart Education Platform Standard Specification,” which provides an important basis for the construction and application of the smart education platform system ^[11]; on February 13, at the World Digital Education Conference organized by China’s Ministry of Education and the Chinese National Commission for UNESCO, the President of China Education Science Research Institute, Li Yongzhi, officially released the “Chinese Smart Education Blue Book (2022)” and the “2022 Chinese Smart Education Development Index Report” ^[12].

Introducing smart education into the smart education platform, connecting the smart education platform to the smart classroom, and introducing ChatGPT into the smart classroom can realize customizable learning robots and virtual assistants, which can provide learning assistance for students and even teachers at any time, adapt to each student’s learning needs, and monitor students’ learning progress ^[13]. The smart

classroom can provide interactive teaching materials and use ChatGPT for knowledge explanation; it can also monitor and record students' learning data in real-time, from which these data can be obtained and analyzed comprehensively so that teachers can better adjust their teaching methods and strategies ^[14]. By utilizing ChatGPT's excellent performance in language processing and logical reasoning, and combining smart teaching facilities, it can achieve the intelligence, efficiency, and personalization of classroom teaching ^[15].

2. Limitations of traditional teaching models and education

In recent years, as times evolve and educational concepts undergo updates, the construction of theoretical systems, service systems, evaluation systems, and incentive systems for the reform of teaching methods, along with the framework model of smart education, has experienced significant development and progress. However, research has found that traditional teaching methods and education still have many shortcomings, specifically in the following aspects:

- (1) Lack of personalized learning: Traditional education usually adopts a standardized teaching method, which cannot meet the personalized needs of each student. The traditional model is unable to provide personalized learning experiences and teaching content for students with different learning styles, interests, and competency levels.
- (2) Lack of immediate feedback and guidance: In traditional education, students generally wait for teachers to mark assignments or conduct tests in order to receive feedback and guidance. This leads to students being unable to correct mistakes and improve learning methods in a timely manner, thus missing the opportunities to improve learning outcomes.
- (3) Limited teaching resources: The teaching resources of traditional education mainly rely on teachers and paper-based textbooks, which are limited by time and space. Student learning relies solely on the knowledge imparted by teachers in the classroom without diverse and rich learning resources.
- (4) Difficulty in quantifying and evaluating teaching effects: It is often difficult to accurately evaluate students' learning outcomes and teaching effects in traditional education. Simply relying on traditional examination scores cannot comprehensively reflect students' overall competency and potential and cannot provide accurate evaluation and feedback.
- (5) Lack of in-depth analysis of education data: Traditional education cannot conduct in-depth analysis of students' learning processes and behaviors. Teachers face challenges in obtaining comprehensive data, understanding students' learning situations and needs, and finely adjusting and improving teaching methods and content.

3. Smart education model based on ChatGPT

In response to the obvious shortcomings of the traditional education model in personalized learning, immediate feedback and guidance, teaching resources, assessment, and education data analysis, this article proposes a smart education model based on ChatGPT. By leveraging ChatGPT and data analysis methods, the smart education model can make up for these shortcomings. The infrastructure of this model is shown in **Figure 1** and it mainly includes four aspects:

- (1) Personalized learning: By identifying the diverse needs of students, the model can provide personalized learning experiences based on their actual situation, such as recommending various teaching materials as well as questions, and adjusting teaching progress in real-time for different students.

- (2) Smart tutoring and assessment: The model can automatically provide educational assistance functions for teachers and students, such as answering questions and solving doubts, providing visual explanations, automating assessment of assignments, etc., and can also record students' learning performance and conduct comprehensive evaluations.
- (3) Educational content creation support: The model can automatically provide various texts related to education and teaching, such as articles, lesson plans, etc., providing support for teachers' textbook compilation and courseware production.
- (4) Education big data analysis: The model can assist in the collection, processing, and analysis of vast amounts of educational data, and apply them to optimize teaching content, personalized adjustments, student performance evaluations, etc., according to the analysis results.

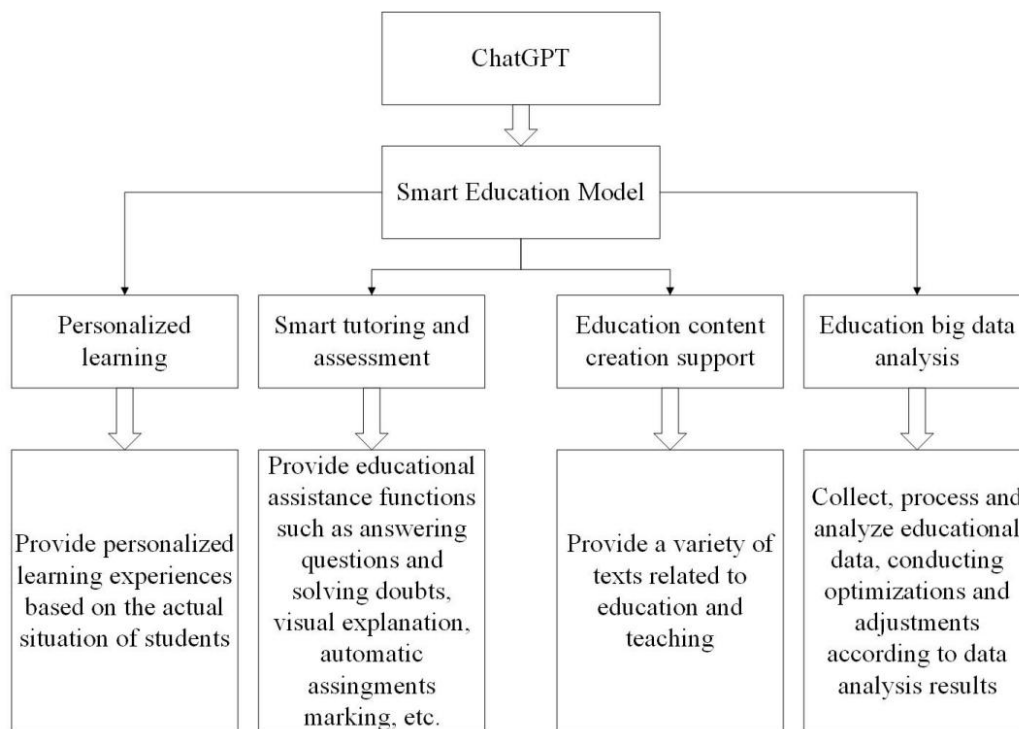


Figure 1. ChatGPT-based smart education model infrastructure

By using smart classrooms, real-time monitoring and evaluation of students can be carried out through various forms such as image processing and facial recognition technology, thus better grasping students' learning situations and providing teachers with personalized educational methods and support. Natural language processing technologies like ChatGPT can quickly and intelligently identify students' problems, recommend related knowledge points, and provide solutions. Smart classrooms can help teachers better understand students' learning situations, thus facilitating proposal of teaching plans, which can be adapted and adjusted accordingly. It can also realize attendance, grade management, quiz assessment, and other functions, greatly improving teaching management efficiency. Based on ChatGPT, smart classrooms can broaden the scope of knowledge acquisition, and recommend personalized courses, resources, question banks, and other content for students through data analysis and information collection, developing interesting, timely, and inspiring learning scenarios to unlock students' learning potential.

4. Smart education model design

4.1. Personalized learning

Personalized learning is a student-centered learning method. During the teaching process, ChatGPT is used in a dialog form to accurately and efficiently identify the different learning needs of students, thereby providing personalized teaching resources, content, methods, and approaches in a targeted manner.

4.1.1. Significance of implementing personalized learning

Tailoring appropriate learning plans according to each student's characteristics, rather than enforcing uniform standards, can greatly improve their learning efficiency. Taking into account variations in students' knowledge levels, learning interests, and other factors, and following the completion of fundamental knowledge learning, tailored teaching resources and content can be provided to accommodate individual differences among students. This approach better satisfies diversified needs, effectively stimulating students' learning interests. Utilizing ChatGPT's capabilities of collecting and integrating educational resources, educational resource sharing can be achieved between schools as well as teachers, thereby breaking down learning barriers and reducing learning thresholds^[16-19].

4.1.2. Application of ChatGPT technology in personalized learning

(1) Learning process data analysis

Through the learning management system of smart classrooms, the data of student learning process is collected to create student learning profiles. This innovative educational model provides students with unique personalized learning experiences and improves learning efficiency and outcomes in multiple ways. By utilizing the learning process data to recommend targeted teaching materials, generate handouts, and design practice questions, tailored services are provided to meet the diverse needs of students and improve learning efficiency.

(2) Predictive teaching guidance

As an advanced language model, ChatGPT is capable to collect student's learning dialogue data in the past, which can be combined with each subject knowledge for in-depth analysis and processing. Based on the learning dialogue data, ChatGPT can predict future student learning processes and recommend targeted knowledge points and solutions promptly, thus providing students with personalized and accurate learning guidance and support.

(3) Competency assessment and knowledge mastery monitoring

Through the analysis of student question-answer dialogues, task completion data, and other data, students' competencies and knowledge can be monitored and improved individually in real-time. By identifying mistakes, intelligent feedback can be provided to teachers and students based on factors such as knowledge points, difficulty levels, and interactions, hence allowing teachers to accurately assess students' knowledge mastery.

(4) Establishing a student learning profile

Before applying ChatGPT, student learning profiles are established through detailed descriptions of students. In addition to basic information like age, gender, major, and so on, a detailed description of students' grades, personality preferences, interests, and learning characteristics is also required to construct a feature vector for the student learning profiles. By processing student data using deep learning technology, and discovering students' characteristics, teachers can better understand students' learning needs and individual characteristics, and provide more personalized and accurate educational services accordingly, as shown in **Figure 2**.

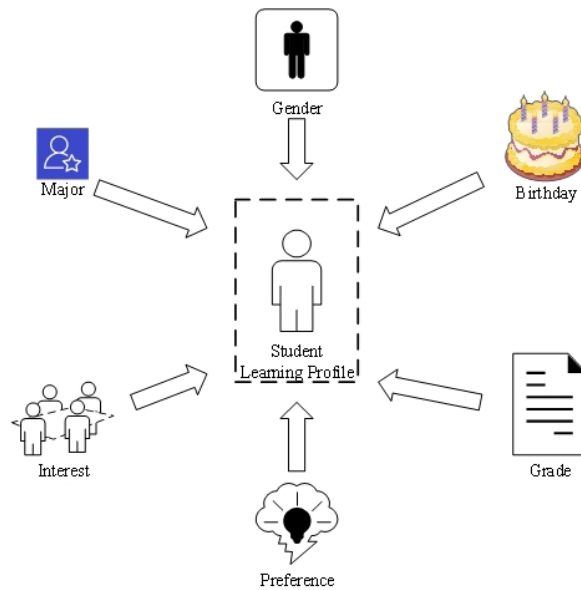


Figure 2. Establishing a student learning profile

(5) Providing personalized educational resources

Based on the current student learning profiles, ChatGPT can be used to build personalized content recommendation systems. The system provides each student with customized learning resource recommendations according to their personality, learning characteristics, and reading habits, such as personalized libraries based on semantic analysis, and smart tutoring for questions-and-answers (Q&A) based on smart tutoring.

(6) Smart testing and assessment

The test questions are personalized and time-sensitive according to the difficulty and coverage of knowledge points, constructed with the assistance of natural language processing technology. Through continuous evolution, single knowledge points are expanded to multi-node knowledge points, and simple basic questions are elaborated to complex comprehensive questions, enabling the creation of a vast and diverse test bank. This serves as the basis for setting objectives through real-time student testing, guiding students towards effective learning. For example, for the knowledge points that are poorly mastered, ChatGPT can design targeted learning content and set detailed methods for learning, testing, and assessment.

4.2. Smart tutoring and assessment

Through analyzing and researching the learning needs of each student, ChatGPT's smart technology is used to provide tailored teaching content and online tutoring services for students. The overall framework for smart tutoring and assessment is displayed in **Figure 3**.

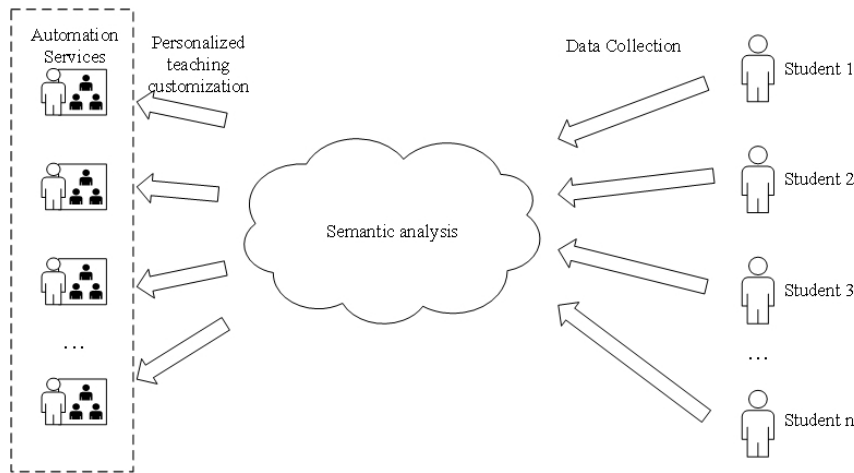


Figure 3. The overall framework for smart tutoring and assessment

(1) Data collection

To achieve smart tutoring and assessment, it is necessary to use data aggregation technology to analyze students' learning behavior data. By collecting various data of students' learning activities, such as personal information, past learning records, exercise answers, and online search records, a complete trajectory of student development can be established. By using data aggregation technology for data mining, students' strengths, weaknesses, specialties, interests, and other relevant factors can be identified, and personalized teaching plans can be tailored to improve teaching effectiveness.

(2) Semantic analysis

Natural language processing technology is utilized to analyze students' answers and questions. Through this analysis, the logical relationship and semantic structure between questions and answers can be identified, thus providing targeted tutoring. Additionally, the dialogue process between students and machines is not only a personalized education tutoring process but also an evaluation method for students' language expression and thinking depth and breadth.

(3) Personalized teaching customization

On top of that, it is necessary to generate customized teaching and learning plans for each student by establishing accurate algorithm models and training data sets. In this process, students have the flexibility to assign ChatGPT any nickname according to their preferences, thus reducing the machine concept, narrowing the gap between human and machine, and improving the human-computer interaction experience. ChatGPT acts as a smart tutor based on students' personal information and other relevant factors, providing personalized tutoring and guidance to promote the development of their learning interest and self-learning ability. For example, during exercises, ChatGPT can provide corresponding exercises for specific knowledge points that require improvement; during assessment of students' cognitive levels, ChatGPT can predict the difficulties they may encounter in the future based on their past learning records and response patterns and implement helpful targeted measures. This customized teaching method can improve students' learning effectiveness and grades and promote their academic success and comprehensive development.

(4) Automation services

Furthermore, automation services should be realized in order to achieve smart tutoring and assessment. For example, online teaching platforms provide students with 24-hour online tutoring and exam

question bank sharing, and comprehensively analyze students' learning data. This not only achieves automation of student guidance services but also liberates teachers and students in terms of time and space, providing students with more convenient ways to acquire knowledge.

Various technical means and tools are needed to achieve smart tutoring and evaluation, including student basic data collection, natural language processing, machine learning models, online education platforms, cloud computing technology, etc. These technologies are deeply integrated to build a sustainable and innovative mode of education, stimulating students' learning potential, and transforming their passive and aimless approach to learning, with the goal of improving learning efficiency and effectiveness. Teachers can guide students in a targeted manner by obtaining their question-and-answer information about relevant subjects. Automated systems can be used to monitor students' online activities, providing prompts and adjusting tasks as necessary.

4.3. Educational content creation support

Educational content creation acts as an important support for teaching, as appropriate teaching content can effectively improve teaching quality and make teaching activities more streamlined. Therefore, it is necessary to establish a complete teaching content creation platform, as shown in **Figure 4**.

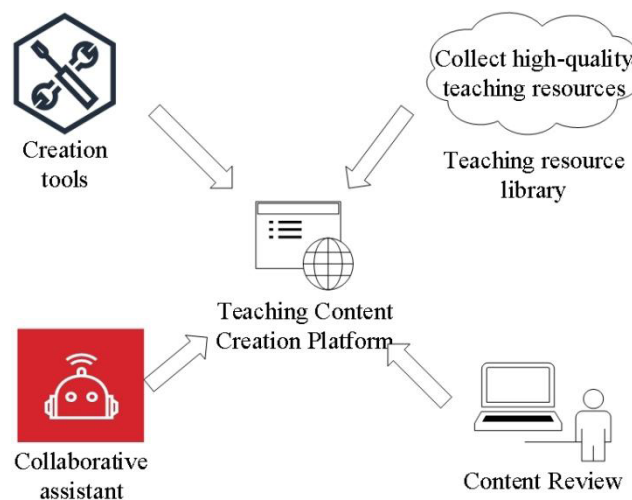


Figure 4. Teaching content creation platform

(1) Teaching resource library

Collecting and organizing high-quality teaching resources in relevant fields can provide teachers and students with rich learning materials and teaching guides. Storing and managing standard data can improve the accessibility and utilization efficiency of resources, with the aim of establishing a convenient teaching resource library for easy retrieval.

(2) Creation tools

Various forms of online and offline teaching content creation tools can be provided, such as text editors, PowerPoint presentation editors, programming tools, image processing tools, etc. The introduction and application of these tools have a significant impact on teachers and students in creating teaching content and promoting teaching innovation. Through these tools, users can easily and quickly create teaching content, enhance teaching effectiveness and students' interest in learning, and promote the integration and innovation of interdisciplinary teaching.

(3) Collaborative assistant

Team collaboration functions are necessary to allow edit, review, and publication of teaching content by multiple people at the same time. Collaboration tools enable functions such as version control and permission management to ensure smooth and effective collaboration. Moreover, advanced technical means and methods are required to enhance the quality of teaching content creation, mainly including artificial intelligence analysis, natural language processing, etc.

(4) Content review

To establish a complete content review mechanism, it is necessary to not only evaluate the teaching content created qualitatively and quantitatively, but also provide corresponding feedback to the creators. This mainly includes bi-directional review and grading mechanism. Bi-directional review allows content creators to share their teaching content to the online community after preliminary editing, and obtain collaborative creation and content review from other users in the community. The grading mechanism added to the teaching content creation platform allows users to evaluate the quality, difficulty, completeness, and other indicators of teaching content, providing guiding information for students and teachers.

Teaching content creation platform is built upon the establishment of a comprehensive teaching resource library, the provision of a series of online and offline teaching content creation tools, and the construction of a scientifically reasonable content review mechanism.

4.4. Big data analysis of education

Education big data analysis has become a hot topic in the current education field. By collecting, organizing, and analyzing relevant data, it is possible to better understand students' learning situations, optimize and personalize teaching content, evaluate students' learning outcomes, and adjust student development evaluations based on the data analysis results.

To conduct education big data analysis more efficiently, a simplified mathematical model can be established as follows:

There are n students and m teachers who conduct end-of-semester evaluations on students who participate in related courses. Given the student achievement data matrix $G_{n \times m}$, where each element g_{ij} represents the grade of student i in the course taught by teacher j , each course corresponds to different weight coefficients w_1, w_2, \dots, w_m , representing different factors that influence student grades.

(1) Learning status data

Each student's knowledge mastery and learning plans of each course can be intelligently tested to understand their current learning status. Let the status of student i in the j -th course be s_{ij}^{status} , with a range of 0, 1, or 2, representing poor, normal, or excellent.

(2) Learning interest data

Each student's learning interests and preferences for each course can be understood through smart dialogue, and the data can be normalized based on their feedback. Let the interest value of each student i in the j -th course be $s_{ij}^{interest}$, with a range between 0 and 1.

(3) Learning difficulty data

Each student's learning difficulties in each course can be known through smart dialogue, and appropriate suggestions and assistance can be given based on the data. Let the learning difficulty of each student i in the j -th course be s_{ij}^{diff} , representing the learning difficulty coefficient.

Lastly, a learning standard is set to indicate the average level of students and the range of high or low performance, in order to give specific evaluations and corresponding suggestions for student development.

5. Problems and improvement direction

(1) Privacy protection issues

The personalized tutoring approach utilizes student data as core information, thus issues related to user data privacy protection and information security should be considered during the implementation process. Relevant technologies can be used to increase the security of the artificial intelligence system such as multi-layer encryption, anonymization, and model pruning.

(2) Expensive customized services

Personalized learning method using artificial intelligence increases the cost of the technology and technical support. There are problems such as matching courses with students and using a secure and reliable educational platform to provide customized services. These problems can be addressed by increasing interactivity and communication, presenting difficult-to-understand knowledge in videos, formulae, models, and derivations, and authorizing the system to automatically provide custom strategies to reduce the cost of customized services.

(3) Strengthening coordination with traditional classrooms

The use of artificial intelligence technology in learning does not mean that traditional teaching methods and the use of excellent course resources should be replaced; rather, it should run collaboratively with them. Increased investment in online education is essential to promote educational innovation and integration with traditional classrooms, thus effectively improve students' practical and innovative abilities.

With the progressive advancement of technology, the application of ChatGPT in smart classrooms is still far from perfect. In order to address current problems, research should be strengthened to build smart tutoring and robust learning status evaluation systems. Through the aggregation of data from smart classrooms, big data analysis, smart management technologies, as well as the use of ChatGPT to achieve end-to-end processing from input to output, personalized learning becomes the forefront of future educational digital transformation. Although there are some technical and practical challenges related to coordination with traditional classroom teaching and data protection that require human intervention, the transition to smart education, technology-oriented teaching approach, and fully tailored and personalized learning will continue to take root, thus exerting a profound impact on the development of Chinese education.

6. Discussion and conclusion

The education model based on ChatGPT will develop further and thrive under the guidance of smart education and the support of smart classrooms. Its fundamental goal is to create a new path that better suits students' need for improving learning efficiency and stimulating innovative potentials. This model emphasizes collaboration, personalization, and differentiation, which can better integrate educational resources, promote the improvement of teaching quality, meet the demands of large capacity and customization, and conduct accurate analysis and evaluation while designing corresponding teaching models. On this basis, it strengthens the collaboration between universities and relevant industries, offering practical knowledge training for students. In addition, with the development of smart education in the new environment and the continuous progress of society, during the implementation of smart education, it is necessary to:

- (1) strengthen overall supervision and pay attention to the process and aspects of the entire course operation.
- (2) address the issue of data security, data protection integrity and privacy.
- (3) stimulate students' participation in practical innovation, encourage them to maintain an open and inclusive attitude towards new technologies, and highlight the exploration of solutions beyond conventional methods.
- (4) further strengthen practical teaching, integrating smart education into engineering practices, and achieving organic combination of all teaching stages.

In summary, researching and applying smart education model has great practical significance for universities. It can significantly improve the quality of education and teaching, optimize the learning process, and provide more accurate learning plans and tracking services for students in various levels and disciplines. It also promotes students' comprehensive development and innovation abilities, and lays a solid cultural foundation for promoting Chinese characteristic modernization and achieving high-quality economic development.

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Disclosure statement

The authors declare no conflict of interest.

Author contributions

J.W. conceived the idea, designed the study, and supervised the research project. H.X. contributed to the conceptualization of the paper, conducted data analysis, and wrote the manuscript. Y.Z. provided expertise in smart education technologies and contributed to the literature review. C.X. conducted experiments, collected and analyzed data, and contributed to the discussion section. L.Z. provided critical feedback and suggestions for improving the paper's content and structure. H.C. contributed to the data analysis and interpretation. X.C. reviewed and revised the manuscript for intellectual content and clarity. All authors have read and approved the final version of the manuscript.

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