

# Study on the Changes in College Students' Learning Behaviors under ChatGPT-based Interventions: A Case Study of Hunan University of Technology

Juan Liu <sup>1,\*</sup>, Shuang Tan <sup>1</sup>, Pingping Kong <sup>1</sup>, Lingfeng Deng <sup>2</sup>

<sup>1</sup> Hunan Institute of Technology, Hengyang, 421002, China

<sup>2</sup> Hunan University of Science and Engineering, Yongzhou, China

\* Corresponding author: Juan Liu (Email: hnhylj@hnit.edu.cn)

---

**Abstract:** Generative artificial intelligence, exemplified by ChatGPT, has garnered significant attention from the global technology community. Scholars suggest that this technology could lead to profound transformations in areas such as education and research. As digital information continues to evolve, the disruption of traditional educational models by AI-driven innovations appears to be an inevitable progression. This study aims to explore whether generative AI facilitates or impedes the development of education, its impact on traditional offline educational models, and its potential to enhance student learning outcomes. Utilizing sampling techniques, surveys, data mining, convolutional neural networks, and logistic regression, this research systematically investigates and critically analyzes college students' perceptions of the advantages and disadvantages of ChatGPT compared to conventional learning methods, the degree of its influence, and potential future implications.

**Keywords:** ChatGPT; 'ChatGPT+Education'; Higher Education; Artificial Intelligence.

---

## 1. Introduction

As technology advances, information technology such as artificial intelligence is gradually being integrated into the education sector. College students, as a key component of the educational structure, have learning patterns and habits that play a decisive role in educational innovation and future trends. Currently, breakthroughs and developments in machine learning have given rise to more sophisticated technological innovations, such as generative AI. This type of AI differs from traditional AI systems in its ability to create new content on its own, rather than just generating responses based on input. Thanks to deep learning techniques, generative AI is able to generate new digital content, such as video, images, text, and audio, by analyzing training samples. As a representative of generative AI, ChatGPT (an AI program based on language models) has recently become rapidly popular around the world, and its application and potential risks in the education field have attracted widespread attention. Discussions about the use of ChatGPT in education and its development prospects have become a controversial topic: some are optimistic about the future potential of ChatGPT and related generative AI in teaching, learning, and educational research, while others have reservations, fearing that it may lead teachers and students to become technology-dependent and gradually lose their critical and analytical skills.

In this context, it is particularly important to study the impact of information technology, especially generative AI, on the traditional learning styles of college students. The purpose of this paper is to analyze the potential strengths and possible weaknesses of ChatGPT and other related generative AI in advancing traditional education and to delve into the changes that these technologies have brought about in the learning styles of college students, as well as the challenges and opportunities that these changes may trigger.

## 2. Literature Review

In the context of the rapid development of "digitalization," the integration of generative artificial intelligence and higher education is an inevitable trend, and the informatization and digitization of school education is also a major feature in the context of the era. According to the research needs, the team members reviewed a large number of related literatures at home and abroad and sorted out the collected domestic and foreign literature from the three aspects of education digitalization development mode, education digitalization development prospect, and education digitalization development system in need of improvement.

### 2.1. AI-Enabled Teaching: Integration & Optimization

The introduction of artificial intelligence technology has injected a brand-new impetus into education. From the macroscopic level of education, generative AI needs to be fully integrated into higher education objectives, curricula, teaching methods, and evaluation systems in order to promote comprehensive reform of education and teaching. Lixin Xia and Zongkai Yang (2023) proposed that generative AI should run through the four aspects of the talent cultivation system, intelligent learning space, science, education, research and innovation highland, and management service mode in order to realize the digital transformation of higher education. Jia Tong and Jiandong Cai (2024), on the other hand, detailed the transformation and evolution process of generative AI in the form of educational productivity from the perspective of educational productivity reconstruction. Kai Zhou (2024) pointed out that AI optimizes learning methods and stimulates learners' sense of autonomy by simulating human consciousness and thinking processes, thus enhancing learning efficiency and quality and promoting the development of deep learning. Chengzhe Han and Ci Xuan (2024) summarized the application of AI in personalized

learning, arguing that it can provide personalized teaching support based on students' characteristics, which significantly improves the precision of education. In addition, Sun Dan et al. (2024) showed that the application of generative AI (e.g., ChatGPT) in programming learning not only improves learning efficiency but also effectively promotes knowledge internalization and transfer. Overall, the application of AI technology in education presents significant advantages such as intelligence, customization, experience, convenience, and efficiency (Kai Zhou, 2024).

## 2.2. AI in Education: Innovation & Exploration

At the micro level of education, Lu Yu and Yu Jinglei (2023) took ChatGPT as an example to explore the diversified applications of generative AI from four dimensions: teacher teaching, learning process, educational evaluation, and academic counseling. Yanhua Wang and Shengjun Li (2024) pointed out that the combination of generative AI and the classroom can not only improve students' learning motivation but also ensure the learning effect. Zhao Liuwei & Cui Rui (2023) believe that teachers use generative AI to improve teaching methods, which helps to expand the radiation scope of higher education. In terms of teaching design and method innovation, Hu Qintai et al. (2021) proposed a higher education teaching evaluation system based on artificial intelligence, which realizes the monitoring and analysis of the data of the whole process of education by means of intelligent perception and evaluation algorithms. Gu Xiaoqing et al. (2018) explored the intelligent expansion of the "learning map" tool, which provides data support for teaching design and effectively improves teachers' decision-making ability. In terms of personalized learning paths and support, Li Zhihua et al. (2024) explored the application of artificial intelligence in university mathematics education, pointing out that intelligent tutoring and learning path recommendation can meet the diverse needs of students. Kong Weiliang et al. (2020) proposed an adaptive learning path construction model based on an improved ant colony algorithm, which effectively solved the problems of learning disorientation and cognitive overload. In terms of learning behavior analysis and support, Sun Dan et al. (2024) analyzed the behaviors of college students when using ChatGPT for programming learning, found that it had a significant effect on shallow and middle knowledge exploration, and put forward corresponding suggestions. Liu Xiao (2023) designed an artificial intelligence-based classroom learning behavior monitoring system, which can efficiently identify students' behavioral trajectories and achieve personalized and untraceable monitoring.

## 2.3. AI in Teaching: Convergence & Optimization

Although AI technology has demonstrated significant potential in the field of education, its development faces numerous challenges, including data privacy and security concerns, difficulties in achieving synergy between technology and human agency, shifts in teachers' roles, academic misconduct, and ethical dilemmas in education. Data Privacy and Fairness: Li et al. (2024) emphasized that AI applications in education must prioritize the protection of data privacy while ensuring fairness and diversity in educational environments. Balancing these factors is essential to maintaining trust and equity in AI-driven systems. Human-

AI Interaction: The issue of fostering positive interaction between AI technology and learners remains critical. Liu Hongxia et al. (2020) highlighted that technological empowerment should focus on cultivating learner autonomy. Over-reliance on AI can weaken students' initiative and critical thinking, which are essential for effective learning. Reshaping Teachers' Roles:

The integration of AI into education necessitates a redefinition of teachers' roles. Hu et al. (2020) argued that teachers must cultivate skills that AI cannot replicate, such as humanistic care, emotional intelligence, and innovative thinking. This approach ensures that educators maintain a central, irreplaceable role in the learning process. Academic Misconduct and Ethical Concerns: The use of generative AI in academic creation has raised concerns about academic misconduct and the erosion of educational ethics. Jiao (2023) noted that excessive reliance on generative AI exacerbates the weakening of students' agency in academic work, posing a challenge to the integrity of education. Addressing the Challenges:

To tackle these issues, it is crucial to enhance conceptual understanding, foster a robust and adaptive system, and establish institutional safeguards. These measures can stimulate educational innovation, ensure ethical AI integration, and promote the sustainable and high-quality development of education. In conclusion, the deep integration of generative artificial intelligence with higher education has become an inevitable trend. However, the journey toward education informatization still faces numerous practical challenges, necessitating continuous efforts to refine the digitalization of education systems. Effectively applying generative AI models in education has emerged as a critical focus within the field of educational technology. This paper aims to provide a comprehensive analysis of the current state of generative AI in higher education, examine its trends and developments through data-driven insights, and delve into its integration and innovation with traditional higher education practices. The goal is to offer both a theoretical foundation and practical guidance to support and inform the transformative changes occurring within higher education.

## 3. Data Collection and Descriptive Analysis

### 3.1. Data Description

Data on comments and related policy information about ChatGPT were collected, visualized, and analyzed from short videos, microblogs, and catechism platforms using web crawler technology.

The survey instrument was meticulously crafted, leveraging both quantitative data and qualitative insights gleaned from extensive interviews with educators in the field. Employing a two-stage sampling technique, we amassed a total of 568 questionnaires, from which 483 were successfully retrieved, yielding an impressive response rate of 85.03%. The study is segmented into four comprehensive sections: demographic details, assessment of traditional learning, engagement with generative AI, and an appraisal of generative AI's efficacy. Demographic details encompass gender, academic standing, and scholastic performance. The assessment of traditional learning delves into the satisfaction levels, perceived benefits, and identified drawbacks of conventional educational methodologies. The engagement with generative AI examines satisfaction, comprehension,

intent to utilize, frequency of engagement, and the contexts in which it is employed. Lastly, the appraisal of generative AI's role in learning evaluates its comparative advantages and disadvantages to traditional learning, its practical application, and the broader impact it has on educational outcomes.

### 3.2. Descriptive Analysis of Data

#### 3.2.1. Analysis Of the Present Situation of College Students' Traditional Learning

Figure 1 shows students' recognition and evaluation of offline education, with 68.12% of students believing that traditional education can meet their learning needs, reflecting high satisfaction with existing education methods. However, 31.88% of the students expressed dissatisfaction, suggesting the need to explore new educational models to meet the needs of students.

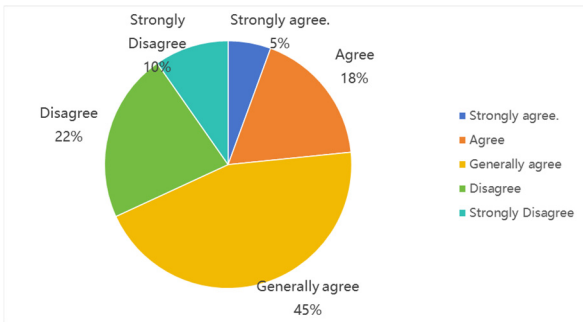


Figure 1. recognition of learning requirements in offline education.

Table 1 shows the advantages of traditional learning. 74.33% of students think face-to-face communication can improve their interest in learning, 66.87% of students value instant feedback, and 53.00% of students approve of good learning atmosphere, 50.93% of students welcome targeted teaching. However, only 38.10% of the students think that the offline education is excellent in improving the learning effect, which shows that there is still room for improvement.

Table 1. Advantages of traditional learning.

Category	Percentage	Category	Percentage
Exam-oriented Education	74.35%	Positive Learning Environment	53%
Dual Teacher Classroom	58.10%	Overseas Experience	50.93%
Campus Activities	66.87%	Others	16.98%

Table 2 shows the disadvantages of traditional learning, with inflexible time arrangement (73.50%) and uneven teaching quality (70.81%) as the major disadvantages. Unexpectedly, high learning costs accounted for only 36.02% and were no longer a major concern. The single learning content (42.44%) also showed the limitation of traditional learning content.

Table 2. Disadvantages of traditional learning

Issue Category	Percentage	Issue Category	Percentage
Inflexible Time Arrangement	73.50%	Monotonous Learning Content	42%
High Learning Costs	36.02%	Others	18.84%
Uneven Teaching Quality	70.81%		

#### 3.2.2. ChatGPT Usage Phenomenon Analysis

Different learning paths meet the needs of all kinds of students. Among them, the digital tools integrated with generative artificial intelligence are popular among college students, and their satisfaction rate is as high as 67.28%. Among the college students, 65% of them have tried generative artificial intelligence, and 80% of them use it frequently, which shows its wide application in the academic field. Generative Artificial Intelligence (AI) was mainly used to assist homework (71.57%), reading comprehension (59.11%) and thesis writing (38.34%), while memory assistant function was used less (39.94%). Students generally acknowledged its positive role in learning, but also expressed concern about its potential problems, as detailed in Figure 2. Most students think that generative artificial intelligence has a positive effect on reducing the pressure of study and improving professional quality, but they have reservations about the effect of enhancing motivation and creativity.

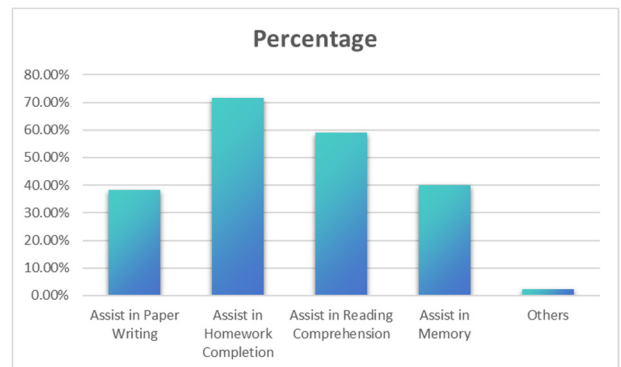


Figure 2. Application of production artificial intelligence for college students.

## 4. Artificial Intelligence CNN Emotion Analysis Based on Network Evaluation

Using the crawled comments, the corresponding features in the comments are extracted, and a CNN sentiment analysis model is built to analyze people's sentiment tendency analysis of generative AI.

### 4.1. Structural Building of the Model

Input layer: the first layer is the leftmost  $N \times d$  text matrix in Figure 3; each row is a word vector with dimension= $d$ , analogous to the original pixel points in the image. Convolutional layer: After kernel sizes of (2, 3, 4), a one-dimensional convolutional layer, each kernel size outputs two channels. max pooling: the third layer is the max pooling layer; different-length sentences can be turned into fixed-length representations after the pooling layer. Output layer: a fully connected SoftMax layer is connected before, then Dropout is used to prevent overfitting, and finally the probability of each category is output.

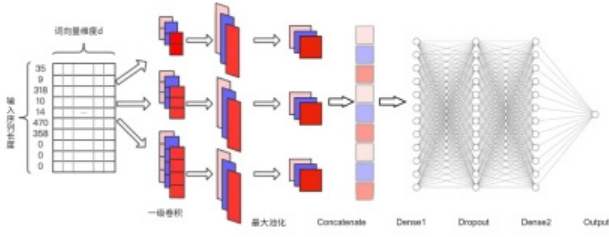


Figure 3. Model structure diagram

Chinese text dataset: New\_edu dataset in THUC News, the collected comments contain a total of 56,699 pieces of data. Test dataset: Existing test dataset of education data in GitHub that has been labeled with sentiment, 6 groups, 2000 articles each.

### 4.2. Test Dataset Goodness-of-fit Analysis

Model testing of the optimum is carried out using unlabeled sentiment datasets from the test dataset; random initialization of embedding is carried out, and the data obtained from each group is analyzed for goodness of fit with the labeled sentiment dataset. The optimal model is saved by fine-tuning the relevant parameters through testing. The following figure shows that the accuracy of the optimal model is 89.000%.



Figure 4. Plot of fit for the test dataset

Table 3. Analysis of factors influencing the willingness to use artificial intelligence

	B	S.E	Wals	df	Sig.	Exp (B)
Promoting Smart Education	0.658	0.145	20.497	1	0	1.93
What level of achievement in the class	0.696	0.177	15.527	1	0	2.006
High cost of traditional learning	-0.587	0.334	3.096	1	0.078	0.556
Constants	-5.423	0.67	65.438	1	0	0.004

When the variable of promoting the development of intelligent education increases by one unit, the logarithmic probability of a student choosing a certain outcome increases by 0.658,  $Exp(B)$  is 1.930; similarly the higher the academic performance in the class, the more willing to use AI tools to assist in learning, the cost of traditional learning has a negative impact on the willingness to try AI, the higher the cost of traditional learning, the more reluctant to try to use AI tools; indicating that For high difficulty is in learning, the current college students are more inclined to traditional learning.

## 6. Conclusion and Recommendations

### 6.1. Conclusion

#### 6.1.1. Characteristics, Advantages and Disadvantages of Traditional Learning

Traditional learning characteristics. Traditional learning is

The crawled comment data will be analyzed for sentiment prediction.

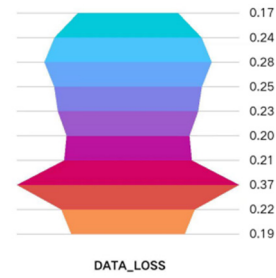


Figure 5. Map of comment iteration data

### 4.3. Emotional Tendency Analysis of AI-Evaluated Texts

The textual dataset of generative AI topics was analyzed for sentiment tendency through the Text CNN model under the deep learning framework. The analysis results show that positive sentiment expressions dominate the text data, accounting for 66.2%, while the proportion of negative sentiment expressions is 31.4%, reflecting a certain degree of worry and dissatisfaction, and the remaining 2.4% are categorized as neutral or other sentiment types. Overall, the topic provoked a more positive emotional response among the public.

## 5. Generative AI: Future Prospects and Adoption Willingness

Logit regression analysis was used to investigate the regression influence analysis between 3 variables and the willingness to try AI for users who have not used generative AI. 'Willingness to try AI' was analyzed as an influencing factor with the explanatory variables: ability to contribute to the development of smart education, which level of the class the grades were at, and the high cost of traditional learning.

based on classroom teaching, and college students' learning mainly relies on lecture-style classrooms and group discussions, with teachers dominating and emphasizing knowledge transfer and professional skills training. Students' learning autonomy is stronger; compared with primary and secondary schools, college students have more autonomy in course selection and learning arrangements but still need to follow the school's teaching program and arrangements. In course assessment, traditional learning takes the final exam and homework grades as the main measure of learning effectiveness, emphasizing the result-oriented knowledge mastery. The combination of theory and practice is not strong, and some courses emphasize the enhancement of the application of knowledge through experiments, internships, and other practical aspects, but the classroom is still the main learning place. Learning resources are relatively single, with school libraries, textbooks, and classrooms as the main learning resources, and the channels for acquiring new

knowledge are relatively single.

**Advantages of traditional learning.** Knowledge acquisition is systematic, and university education ensures that students master subject knowledge systematically through course design, syllabus, and assessment system, which is conducive to building a solid knowledge system. Face-to-face teaching methods facilitate teacher-student and student-student communication. Teacher-student exchanges in the classroom can help students understand complex concepts more deeply, and teachers can adjust their teaching strategies based on student feedback. The college classroom provides students with opportunities to interact with peers and faculty, promote cooperative learning, and build networks for future career development. Teachers are the most informative group of people that college students can contact. Teachers have a more rational understanding of life and social imagination, and they can guide college students' self-understanding and the formation of their worldview and value viewpoints in a silent way, which cannot be provided by artificial intelligence. Teachers' rich professional knowledge and teaching experience can provide authoritative guidance and inspiration for students. Learning is not a closed-door process, and traditional teaching can provide college students with a strong learning atmosphere and academic resources, such as libraries, academic lectures, and laboratories, creating superior learning conditions for students.

**Disadvantages of traditional learning.** Lack of flexibility in the teaching and learning process, the curriculum and teaching content are relatively fixed, making it difficult for students to make adjustments according to their own interests or learning pace. Limitations of learning resources: traditional learning mainly relies on textbooks and teachers; the depth and breadth of knowledge acquired may be insufficient, and it is difficult to keep up with the cutting-edge dynamics of the subject. Insufficient support for students' individualization. The large classroom model limits teachers' attention to students' individual needs, making it difficult to meet diverse learning styles and development goals. Insufficient integration of theory and practice. Despite the depth of theoretical teaching, some courses are not sufficiently practical, and students' abilities in practical application may not be sufficiently honed. Student assessment emphasizes examination results, and the assessment method based on examination results may lead students to emphasize short-term memorization and test-taking skills while neglecting long-term ability development and innovative thinking cultivation. Time and space constraints: class time is fixed, and students must be present on time, which cannot accommodate part-time jobs, club activities, or other personalized needs of some students.

### **6.1.2. The Changing Face of Teaching and Learning with Generative Artificial Intelligence and Digital Tools**

**Changes in learning styles.** The process of teaching and learning in the classroom can be analyzed by AI algorithms to analyze students' learning data and provide personalized learning paths and suggestions to meet the needs of different students. Intelligent algorithms can recommend relevant courses, learning materials, and problem sets according to their own learning interests and learning progress, optimizing the use of resources. AI can adjust the content and difficulty of teaching in real time to help students learn to acquire knowledge at a suitable pace. Students can consult with AI in real time to get answers to their classroom questions, reducing their dependence on real-time tutoring by teachers. Multi-

modal interaction improves learning participation and learning effect, realizing diversified learning interactions and improving participation through voice assistants, text interactions, and image recognition. Efficient data tracking and feedback: AI records learning progress in real time, assesses students' weaknesses and strengths, and provides data support for improving learning strategies.

**Advantages Introduced by Artificial Intelligence.** Highly personalized student learning: students can customize their learning plans according to their own abilities, interests, and goals, improving learning efficiency and effectiveness. Real-time feedback of the learning process, AI can quickly analyze students' answers and provide instant feedback to help students quickly correct their mistakes. Unlimited learning resources: Through the Internet and AI platforms, students can access quality learning resources worldwide, breaking geographical and time constraints. Flexibility of learning time: students can learn anytime and anywhere, no longer restricted by traditional classroom time and location. Low cost of learning; part of the learning task is undertaken by AI, reducing the reliance on expensive human tutoring and physical textbooks. Immersive technology and interactive systems enhance the fun and engagement of learning and improve independent learning ability.

**Disadvantages of the introduction of artificial intelligence.** Artificial intelligence does not have the ability to read the language, not good insight into the emotional changes in the learning process of students, or the lack of capriciousness in learning. AI cannot completely replace the humanistic care of the teacher; the students access the lack of emotional exchanges. AI can make students overly reliant on technology, leading to an inability to think critically during the learning process, which in turn leads to a weakening of their independent learning and problem-solving skills. The training set of AI requires a large amount of data, and the introduction of AI into students' learning processes will inevitably require the provision of personal data information, which poses the risk of personal privacy leakage and data abuse. Due to the different family environments of students, affected by economic conditions, equipment, and network environments, it is difficult for some students to make full use of AI technology, which may exacerbate the education divide and is not conducive to education equity. Artificial intelligence is rooted in grounding algorithms; if the algorithm is not well designed, it may lead to inaccurate recommended content or biased assessment, and students may enter the algorithmic trap without being able to extricate themselves due to a lack of judgment in the learning process.

## **6.2. Suggestion**

### **6.2.1. Fully Utilize the Advantages of Traditional Offline Education and Combine It with New Technologies**

While traditional offline education has its unique advantages in terms of social interaction, classroom discussion, and emotional communication, the introduction of new technologies can make up for the shortcomings of traditional education in terms of flexibility, access to resources, and efficiency. By integrating generative artificial intelligence (e.g., ChatGPT) with the strong interactivity of offline teaching, a hybrid teaching model of "online + offline" is designed. For example, in-depth discussions and hands-on activities are conducted in offline classes, and AI is used to provide pre-study materials before class, after-class Q&A, and homework tutoring to optimize teaching results. Carrying

out personalized education services, analyzing students' learning behavior data through AI, identifying each student's learning characteristics and shortcomings, and providing teachers with precise teaching suggestions; at the same time, pushing customized learning content to students to help them break through their weak links, so as to achieve the goal of tailoring teaching to students' needs. Carrying out multi-scene integrated teaching, introducing virtual reality (VR), augmented reality (AR), and artificial intelligence technologies in scenarios such as laboratory classes, seminars, and internships to simulate real environments and enhance students' immersion and practical abilities.

### **6.2.2. Exploring Flexible Learning Models That Better Suit the Habits of College Students**

The study time and rhythm of college students are more flexible, and the traditional fixed teaching mode sometimes cannot fully meet the demand. Therefore, a flexible education model should be designed according to the learning characteristics and living habits of college students. Personalized time arrangement. Break the restriction of fixed classroom time and provide online learning resources, such as video courses, interactive exercises and AI tutorials, to realize "learning anytime, anywhere". Split the course content into multiple independent modules, students can choose learning modules according to their own progress and interests, not only to ensure the mastery of basic knowledge, but also to support personalized development. Create a learning community that combines online and offline learning, so that students can maintain social interaction and teamwork even when their time is flexible, and assign group tasks and collaborate in real time through the AI platform. Combine with the real-life scenarios of college students, such as designing vocational skills simulation and life problem-solving training on the AI platform, to make the learning content closer to the actual needs and enhance the learning interest and applicability.

### **6.2.3. Generative AI Complements Traditional Offline Education with Advantages and Disadvantages**

Generative AI can well make up for the shortcomings of traditional education, while traditional offline education can provide AI with supplementary emotional support and socialization and cultivation opportunities. Use ChatGPT to develop an intelligent teaching assistant for college students, providing real-time Q&A, homework guidance, knowledge expansion and other services to help students solve personalized problems while reducing the teaching burden of teachers. Develop a generative AI-based teaching collaboration platform that supports three-way interaction among students, teachers and AI. For example, students can submit questions on the platform, the AI answers them in real time and then marks the key difficulties, and teachers conduct targeted teaching based on the data. In the traditional classroom, AI can generate questions, cases or simulation experiments in real time for teachers and students to interact and discuss, improving the interest and participation in the classroom. Optimizing teaching resource management, combining AI technology to manage teaching databases, and generating summaries, summaries and knowledge maps through natural language to help students quickly access the information they need and improve learning efficiency.

### **6.2.4. Helping College Students Better Understand and Use Generative AI**

Generative AI is a powerful tool, but college students need

to master the right way to use it to maximize its utility. Provide college students with AI subject guidance classes. Offer a specialized course that systematically teaches the fundamentals, application scenarios, and ethical issues of AI technology so that students can understand the potential and limitations of generative AI. For mainstream AI tools (e.g., ChatGPT), provide step-by-step operation guides and example tutorials to help students get started quickly, as well as guide them to master efficient questioning techniques. While promoting the use of AI technology, strengthen college students' understanding of technology ethics, help them correctly view the role of AI, avoid dependence and misuse, and cultivate a critical sense of technology and responsible use habits.

## **Acknowledgments**

We express our gratitude to all authors for their contributions to this paper. We also appreciate the support from Hunan Institute of Engineering and Hunan University of Science and Technology for this research.

We are thankful for the financial support provided by the Hunan Province College Students' Innovation and Entrepreneurship Training Program (Document No. Xiangjiaotong [2024] 118) and the Hunan Institute of Engineering College Students' Innovation and Entrepreneurship Training Program (Project No. S2024 11528027). Additionally, we acknowledge the funding from the Hunan Province College Students' Innovation and Entrepreneurship Training Program (Document No. Xiangjiaotong [2023] 132) and the Hunan Institute of Engineering College Students' Innovation and Entrepreneurship Training Program (Project No. S2023115 28013).

## **References**

- [1] XIA, L., YANG, Z., HUANG, R., et al. (2023). Digitization of Education and Educational Change in the New Era (PEN Talk). *Journal of Central China Normal University (Humanities and Social Sciences Edition)*, 62(05), 1-22.
- [2] JIA, T., & CAI, J. (2024). The change of generative artificial intelligence on educational productivity. *Modern Educational Technology*, 34(01), 107-116.
- [3] LU, Y., YU, J., CHEN, P., et al. (2023). Educational Applications and Prospects of Generative Artificial Intelligence--Taking ChatGPT System as an Example. *China Distance Education*, 43(04), 24-31+51.
- [4] WANG, Y., LI, S., & HUANG, R. (2024). Research on the application of blended teaching mode combining online and offline--Taking higher mathematics course as an example. *China Education Technology Equipment*, (01), 96-100.
- [5] ZHAO, L., CUI, R., JIANG, H., et al. (2023). Research on the deep integration of information technology and higher education teaching. *Journal of Anhui Electronic Information Vocational and Technical College*, 22(03), 95-98.
- [6] JIAO, J. (2023). ChatGPT Boosts Digital Transformation of School Education-What to Learn and How to Teach in the Age of Artificial Intelligence. *China Distance Education*, 43(04), 16-23.
- [7] PAN, Y., QI, W., & WANG, J. (2024). The application of generative artificial intelligence in the education of college students. *Internet Weekly*, (04), 62-64.

- [8] WANSHENG, J., & ZI, T. (2023). Prospects and constraints of ChatGPT in the development of higher education. *Beijing Education (Higher Education)*, (08), 4-9.
- [9] WANG, S. (2024). Obstacles and Countermeasures of Generative Artificial Intelligence to the Governance of Academic Misconduct. *Science Research*, 42(07), 1361-1368.
- [10] LIU, S. Y. (2023). A preliminary study of the impact of generative artificial intelligence on higher education. *China Journal of Multimedia and Network Teaching (Lenten Edition)*, (12), 1-4.
- [11] HE, C., & XIONG, H. (2024). ChatGPT Class Generative Artificial Intelligence Educational Ethical Crisis and Its Response. *China Education Informatization*, 30(02), 81-90.
- [12] ZHANG, L., ZHOU, L., & ZHAO, L. (2023). Generative Artificial Intelligence Educational Application Risks and Their Avoidance - Based on the Perspective of Educational Subjectivity. *Open Education Research*, 29(05), 47-53.
- [13] SUN, D., ZHU, C., XU, Z., & XU, G. (2024). A study on the analysis of college students' programming learning behavior based on generative artificial intelligence. *Research on Electrochemical Education*, 45(03), 113-120.
- [14] HU, Q., WU, W., FENG, G., PAN, T., CHEN, Z., & QIU, K. (2021). Key technology and practice of teaching evaluation in higher education in the era of artificial intelligence. *Open Education Research*, 27(05), 15-23.
- [15] HU, L., WANG, K., & GAO, X. (2020). The Should-be and Real Way of the Integration of Artificial Intelligence and Education and Teaching. *Teaching and Management*, (28), 5-8.
- [16] LIU, H., LI, S., JIANG, Q., & ZHAO, W. (2020). Connotation Transformation, Constraint Bottleneck and Development Path of Self-Regulated Learning Empowered by Intelligent Technology. *Journal of Distance Education*, 38(04), 105-112.
- [17] KONG, W., HAN, S., & ZHANG, Z. (2020). Adaptive Learning Path Construction with Artificial Intelligence Support. *Modern Distance Education Research*, 32(03), 94-103.
- [18] GU, X., SHU, H., & BAI, X. (2018). Teacher tools in the age of intelligence: Awakening data intelligence in learning design tools. *Open Education Research*, 24(05), 64-72.
- [19] YU, M. H., FENG, X., & ZHU, Z. (2017). Exploration of educational application and innovation of machine learning under the perspective of artificial intelligence. *Journal of Distance Education*, 35(03), 11-21.
- [20] MOU, Z. (2017). Rethinking and unraveling personalized learning theory in the era of "Artificial Intelligence +". *Journal of Distance Education*, 35(03), 22-30. G. O. Young, "Synthetic structure of industrial plastics (Book style with paper title and editor)," in *Plastics*, 2nd ed. vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15-64.