

The Power of Smart Classrooms and Enlightened Minds - A Review of Generative Artificial Intelligence in Education

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ABSTRACT

Generative artificial intelligence represented by ChatGPT has attracted wide attention in the field of education because of its powerful generative ability, both personalized learning, understanding the learner's motivation, and providing personalized tutoring and feedback for education. With the advent of the Education 2.0 era, smart classroom has become a strategic choice for the construction of education modernization, and is widely used in higher education and vocational education. Generative AI enlightens students' engineering thinking, computational thinking, design thinking and systems thinking, which not only helps students to master their professional courses, understand what they have learned, and improve their academic performance, but also assists teachers in updating their course content, keeping abreast of students' learning trends, improving their teaching efficiency, and simplifying their work. However, generative AI is faced with expertise gaps and uncertainty about the existence of generated content in its application, as well as ethical issues, and this study proposes that the needs and values of education should be respected, with the aim of efficient and convenient services, and that data-driven and ethical ethics should be emphasized in future development. Smart classroom and enlightened thinking with the application of generative AI is a new way of thinking about educational change, which can help teachers and students to effectively carry out multiple interactions, enable teachers to better understand students, play the role of human beings in education, and truly allow technology to be used for teaching and promote classroom teaching reform.

Keywords: generative artificial intelligence, personalized tutoring, smart classroom, ethics, enlightened thinking

1. Introduction

Currently, Generative Artificial Intelligence (GenAI) tools are rapidly emerging, and their versions are being updated and iterated much faster than expected [1]. Currently, universities and colleges in

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Received 15 January 2024; Revised 25 March 2024; Accepted 15 December 2024; Published Online 15 April 2025.

DOI: [10.61091/jcmcc127a-445](https://doi.org/10.61091/jcmcc127a-445)

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developed countries have released GenAI-related policies, which articulate attitudinal preferences towards the use of GenAI by faculty and students, and provide some guidance suggestions for its use [2]. Generative artificial intelligence is shaping the teaching and learning process in higher education, and in this context, the smart classroom is a product of the “Internet+” environment [3]. Along with the practice and application of generative artificial intelligence in education classroom teaching, education schools have started to explore the practice of smart classroom, and use the concept of smart education to guide and lead teaching research and practice activities [4]. Not only can it help teachers carry out interactive teaching more efficiently, innovate learning styles, and really let technology be used for teaching. In the smart classroom, teachers can solve traditional teaching problems with the help of artificial intelligence teaching platform and use intelligent technology to achieve personalized teaching goals [5]. By creating an intelligent environment to promote changes in the teaching structure, fully stimulate the learners' subjective initiative, divergent thinking and creative potential, so that they can actively participate in learning activities, truly learn to think, learn to understand, learn to gain, and promote their comprehensive development and healthy growth [6].

However, very few studies have been conducted to systematize the power of generative AI in smart classrooms and enlightened thinking. This paper searches Google Scholar's practical research on smart classroom and enlightened thinking in recent years with the support of generative AI. Analyzing the related studies, it is found that the smart classroom can collaborate with teachers to better help students learn. Engineering thinking ability to help students find the key to the most problems, computational thinking ability to effectively integrate artificial intelligence and subject content, design thinking to more efficiently guide students to complete the design, and systems thinking to help students learn the complexity and change of professional and technical knowledge in depth. With the help of generative artificial intelligence, it can realize scientific decision-making based on real data, effective evaluation based on real learning situation, multiple interactions based on intelligent devices, as well as intelligent resource pushing and visualized teaching presentation. In response to the relevant proposals faced, data-driven and policy formulation can be adopted to provide support for learning tools and application platforms, realize effective interaction between teachers and students, reach teaching goals in the process of accurate data feedback, and promote students' intelligent learning.

2. Generative Artificial Intelligence in Education

2.1. *Pedagogical Advantages of Artificial Intelligence*

The development of education informatization has accumulated a large amount of online education data, and more and more scholars apply artificial intelligence technology in teaching classrooms. Yin, S. et al. discussed the performance of an intelligent classroom teaching management system based on sensors and machine learning technology for English classroom teaching. The analysis found that 77.7% of students said they strongly agree with the intelligent management system, and teachers can better grasp the students' status in the classroom and improve the efficiency of teaching [7]. Zhang, X. and Chen, L.'s research shows that AI can accomplish teaching in complex and changing environments, which not only helps students learn independently, but also promotes the interaction between teachers and students, and enhances the communication ability of the English language [8]. Ikedini, A. P. et al. showed that the evolution of AI classrooms enables students to actively participate in the teaching and learning process, and the intelligent grading system reduces the pressure on teachers to assess assignments and allows them to focus more on the teaching task [9].

By analyzing the application of artificial intelligence in teaching, it was found that artificial intelligence correctly understands the learner's motivation and enables educators to provide learners with the right guidance and assistance in the teaching process according to the situation.

2.2. Applications of generative artificial intelligence

2.2.1. Teaching and learning support. Generative Artificial Intelligence as a disruptive technology advances the education system towards modernization. Ruiz-Rojas, L. et al. discuss the potential of generative AI in education using a quantitative research design. Virtual assistants in generative AI are able to provide personalized responses in real time to answer students' questions in a way that improves the coherence of teaching and learning activities [10]. Cooper, G. In the study, ChatGPT replies to education related questions, the ways in which teachers use ChatGPT, and the specific applications of ChatGPT in education were discussed. The study pointed out that ChatGPT helps teacher-workers to design teaching units and related quizzes, and teachers should evaluate the generated resources and make appropriate adjustments in the context of the teaching environment [11]. Liu, M. et al. suggested that ChatGPT has advanced natural language processing technology, which can respond to users' queries in a timely manner, and provides users with personalized learning experiences and educational support that It meets the future needs of talent cultivation in society [12].

Baidoo-Anu, D. and Ansah, L. O noted that generative AI provides important support for educational learning. It provides personalized tutoring and feedback to students to improve learning. Helping to grade student essays and organizing key features of great essays for students. Translating educational materials into different languages, as well as creating interactive learning environments and building adaptive learning systems to reduce the difficulty of questions [13]. Pesovski, I. et al. proposed that generative AI can be programmed to enhance the personalized experience of a student by recommending appropriate teaching resources based on the student's mastery of existing knowledge. A questionnaire survey of 20 college students found that college students had a high level of satisfaction with AI-generated content interactions [14]. George, A. S.'s research suggests that generative AI is capable of providing personalized learning feedback, intelligent research assistants, and self-service content creation. Customizing personalized teaching services for graduate students relieves faculty workload and helps students learn more efficiently [15].

Overall, generative AI technologies have made significant progress in supporting teaching and learning.

2.2.2. Feedback and evaluation. The rise of generative AI still manages to stay ahead of the curve in the rapidly evolving educational environment, with feedback and assessment as one of the key functions, which are becoming more and more widely used in the field of education. SAJADI, S. et al. found generative AI feedback to be actionable and constructive, and capable of filtering out topic-irrelevant feedback results [16]. The rapid advancement in natural language processing technology generated advanced conversational tools, Ibrahim, H et al. assessed whether ChatGPT helps students to complete their assignments. The research found that although with the help of ChatGPT, the course, although it was able to get the desired grade, still had some challenges when dealing with advanced courses [17]. Yan, L et al. study mentioned that GenAI has significant advantages in depth and feedback efficiency over traditional methods by expanding personalized support, and diverse learning resources [18]. Tai, T. Y. and Chen, H. H. J. pointed out that generative artificial intelligence and automatic speech recognition technology bring new opportunities for spoken language learning, which will improve English speaking ability, enhance the ability of contextualized interaction, and reduce the psychological anxiety of spoken language learners. In addition, it will enhance learners' interest in learning [19]. Sun, L et al. used Meta Heterogeneity Analysis, calculated as follows [20]:

$$\text{Cohen's } d : d = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}} \quad (1)$$

$$\text{Correcition factor } J : J = 1 - \frac{3}{4(n_1 + n_2 - 2) - 1} \quad (2)$$

$$\text{Hedges' } g = d * J \quad (3)$$

Through the above equation, it is concluded that generative artificial intelligence can significantly improve the performance of college students and positively affect the learning of various types of subjects.

In summary, the relevant research provides theoretical basis and empirical evidence for the application of generative artificial intelligence in the direction of education.

3. Generative Artificial Intelligence in the Smart Classroom

The integration and development of generative AI technology and smart classroom represented by ChatGPT will lead a profound change in the field of education. It is widely used in many scenarios such as learning situation analysis, generation of personalized teaching plan, intelligent teaching assistant, resource optimization, human-machine interaction, intelligent evaluation and feedback, etc., especially in higher education and vocational education.

3.1. Smart Classroom

The arrival of the era of education informatization 2.0 has provided a new development direction for education work. Long, T showed that the smart education platform includes modules such as big data, artificial intelligence, cloud computing, and mobile learning, which can both keep abreast of students' learning dynamics and help teachers personalize their teaching [21]. Chiu, T. K pointed out six research directions of generative AI in smart classroom, which include Setting up assessment methods to master AI ethics. Evaluating teaching standards and curriculum frameworks in interdisciplinary applications that emphasize students' literacy skills [22]. At this stage, generative AI has become a strategic choice for the modernization of education, heralding the future development of the classroom system towards modernization.

3.2. Application in higher education

Generative Artificial Intelligence is gradually being used in higher education through deep learning models that will generate human-like conversational content. Michel-Villarreal, R et al. in their study emphasized that ChatGP can provide personalized learning tutoring for higher education institutions to supplement teaching resources, refine language learning and communication skills, and provide an innovative learning experience for students in higher education institutions [23]. Jensen, L. X et al. mentioned that ChatGPT, as a digital tool, will shape new teaching roles for teachers in higher education by providing services for teachers to prepare their lessons. It also supports students to think, write, and take the role of a private tutor [24]. Wang, H. et al. found that ChatGPT can provide practical guidance in teaching practice and can meet the professional needs of most education researchers by surveying educators and researchers, etc. using GenAI in American universities [25]. Dai, Y. et al. explored generative Artificial Intelligence and ChatGPT play a role in higher education, which has great potential to drive student innovation and not only develop students' competencies, but also enrich teachers' educational experience [26]. Noviandy, T. R et al. stated that generative Artificial Intelligence can change the work related to higher education institutions, such as personalized learning, simplification of administrative work, and mentioning of innovations. It helps to improve the efficiency of teaching and learning in higher education institutions and create a more attractive teaching and learning space [27].

Summarizing the above related studies, it is found that generative AI in higher education is able to collaborate with teachers to teach students and achieve the purpose of helping students learn.

3.3. *Role in vocational education*

The emergence of novel generative AI technology further pushes the smart classroom towards vocational education. Zhang, Y. et al. mentioned in their study that generative AI technology evaluates the potential and ability of teachers by analyzing academic achievements, teaching experiences, and students' comments through deep learning techniques to improve the direction of talent management in vocational colleges and universities and to provide guidance for vocational education [28]. Duan, J. and Wu, S. et al. discussed the impact of generative AI on the planning process of vocational education, and the analysis pointed out that the personalized career guidance framework constructed by using its natural language processing and machine learning technology is pedagogically sound, marking this vocational education career planning is moving towards a new era of development [29]. Scerri, D. based on constructivism, analyzed the relationship between students and generative Artificial Intelligence case, concluded that GenAI as an advanced assistant is gradually improving the work related to vocational education [30].

The traditional model of vocational education tends to be a one-way transmission of knowledge by teachers, while generative AI can interact with students, plan the careers of vocational education students, and develop their practical skills.

4. **Generative Artificial Intelligence for Enlightened Thinking Skills**

In modern teaching, the use of generative artificial intelligence technology can effectively improve the development of students' enlightened thinking skills, including engineering thinking, computational thinking, design thinking and systems thinking. And it allows students to think and prove a series of concepts, problems, systems, and designs of artificial intelligence. Moreover, the use of artificial intelligence can also simplify, transform and explain the problems encountered in computational thinking, which can effectively help students improve their knowledge and understanding of related courses.

4.1. *Engineering thinking*

With the continuous development of generative AI technology, especially after the rapid rise of AI technology in recent years, which has become widely popular in people's lives, engineering education has also seen a new opportunity for development. A study by Dai, Y. showed that GenAI was used in 59.80% of the designs in a research involving 403 students. The students who used it showed that GenAI as a teaching aid tool can help students to overcome the bridge of non-specialized knowledge and generate ideas and brainstorm [31]. Onatayo, D. et al. stated that generative AI simplifies the decision-making process before construction, improves efficiency during construction, and ensures the integrity of the archive after construction is completed. Driven by advanced technology, generative AI continues to evolve engineering needs and has become one of the powerful tools in the field of engineering learning [32]. Generative AI feeds engineering thinking skills and helps students to find the most effective key points from which to open up the problematic vein.

4.2. *Computational thinking*

Generative AI is useful for forging computational thinking, Liao, J. et al. constructed an intelligent coding scaffolding system and designed pre-test and post-test experiments to compare students' CTS scores before and after IPSSC. And through Shapiro-Wilk test for normal distribution, the test found that intelligent AI significantly improves students' computational thinking, especially problem solving [33]. Kazanidis, I. et al. assessed college students' satisfaction and learning performance with generative AI, comparing student ratings in two groups: early childhood education and computer science. Eighty-eight percent of the preschool participants and 68% of the computer science

participants believed that AI had some importance in education and believed that it helped to generate computational thinking, which led to better mastery of AI techniques [34]. The key to the development of computational thinking skills lies in mining and analyzing the content of the information technology curriculum and effectively combining these elements of the information technology curriculum, the age of artificial intelligence, artificial intelligence platforms, and computational thinking skills.

4.3. *Design Thinking*

Design thinking is not only the thinking and analysis of professional design, but also the understanding of today's social and technological development. Cui, W. et al. proposed that before the class, generative AI helps teachers to design more inspiring teaching content. During the lesson, an interactive classroom is constructed through the ternary structure of teacher-AI-student. At the end of the lesson, the degree of innovation is assessed based on interdisciplinary thinking to synthesize students' abilities. This study demonstrates the effectiveness of generative AI in developing the thinking of business majors and stimulating students' design and creativity [35].

Shalamova, N. and Rice-Bailey, T. study mentioned that generative AI technology is able to generate multimodal content even though the technology industry and teaching in particular are deeply affected. In the context of AI, generative AI helps students to understand the importance of meditative design, improves teacher expertise based on rhetorical theory, and guides students through the design thinking process more efficiently [36]. Using algorithmic thinking in generative AI, design thinking in enlightened thinking can be targeted in technical activities for in-depth elaboration and analysis.

4.4. *Systems Thinking*

When using generative AI to cultivate students' systems thinking, care should be taken to accurately integrate classroom content with AI knowledge and to grasp the operating principles of AI technology tools. Baskara, F. R. et al. constructed an eco-collaborative learning platform based on generative AI, proposing that AI facilitates personalized learning through cognitive reinforcement, writing resolution and peer learning, and the study provides a theoretical basis for the interaction of educational ecosystems with AI [37]. Gonsalves, C. revealed how generative AI affects the critical thinking skills of a Master of Science in Marketing, based on Bloom's Taxonomy, with an in-depth integration of the cognitive processes involved at each level through the cognitive-emotional and metacognitive domains. Enriching critical thinking using AI helps students to understand, integrate, and evolve learning processes more systematically [38].

The above study can effectively develop students' higher-order systems thinking as well as provide them with in-depth learning of complex and changing technical expertise.

5. **Challenges for generative AI**

Currently, the development of generative artificial intelligence is in high gear, with Internet vendors and research institutions releasing large models and demonstrating their ambition to "reshape the world" as they compete for the top spot. However, intelligence is not a panacea, and the commercialization of generative AI has led to gaps in expertise and uncertainty about the content generated, as well as widespread discussion of ethical issues.

5.1. *Gaps in expertise and uncertainty of generated content*

Large models require large computing power, due to the high cost of training large models, long investment cycles, high risk, and technology applications facing expertise gaps and uncertainty in generated content. Wach, K. et al. asked about AI model development controversies and threats, and

received suggestions. There is a potential to create damaging or deceptive content using deductive methods of reasoning. For example, there is a risk of insufficient information quality control, false information, content forgery or algorithmic bias. In addition, the use of forgery techniques in various industries is gradually showing a raw trend and attention should be paid to the digital environment [39]. Bandi, A. et al. reviewed generative artificial intelligence systems for hardware, software and user days. Through hierarchies such as language modeling and generative adversarial networks, it was found that the continuous development of Web 3.0 ultimately led to the advancement of generative AI. Among them, the decision-making process of deep neural networks is usually not easily revealed by humans, and the lack of interpretability and transparency exists, leading to a lack of trust [40]. Dwivedi, Y. K et al. collated 43 experts from different disciplines have got to share, and the collation found that these experts pointed out that there are certain limitations in the generative AI industry. For example, there are interferences with practices, there are threats to privacy and security, as well as facing bias, misuse and misinformation. Based on the collated opinions, this study, identified three ChatGPT topic areas, and future directions [41].

Currently, generative AI, although the number of published models is large, and each has its own focus in terms of algorithms, arithmetic power, and data strengths. However, R&D efforts are fragmented, and expertise and generated content are also major issues faced.

5.2. *Ethical issues*

Generative artificial intelligence, as one of the most representative disruptive technologies at present, behind the intelligent application, whether the algorithm meets the ethical requirements is increasingly questioned. Chen, Y. and Esmaeilzadeh, P. analyzed the current status of AI application in the field of medical science, and found that there existed certain threats to AI systems in the data collection, model development and implementation stages. In the data collection and processing stage, there are integrity and confidentiality threats, and in the model training order and construction stage, there are threats of performance deterioration and deceptive data. In the adversarial training phase, there are threats of false information and deep forgery, and new unknown threats may be faced during data extraction by AI models [42]. Kirova, V. D. et al. point out that with the gradual application of AI, ethical issues have emerged. For example, ethics covers the emergence of value issues such as privacy, fairness, transparency, and responsible person during the progress of generative AI. Among them, privacy is one of the extremely important issues, where sensitive personal information is involved in the system, giving rise to debates related to consent and data protection. Based on this, it is extremely important to design generative AI that conforms to human values and ethical standards [43]. Hacker, P. et al. From a legal perspective, generative AI suffers from discriminatory content, interference in the manufacturing environment as well as underrepresentation and stereotyping. Discriminatory content puts the protected group at a disadvantage and generative AI is jointly and severally liable for the presence of discriminatory output [44].

In general, the higher the risk of a generative AI system, the higher the degree of oversight required to ensure that the use of generative AI is consistent with human values and ethics and achieves a higher level of social acceptance.

6. **Trends of generative AI in education**

Generative AI should also aim to respect the needs and values of education and provide more accessible and efficient services as a means of defining appropriate boundaries for education and teaching. Developing policy guidelines and implementation frameworks to ensure that generative AI systems operate within predetermined boundaries and do not compromise human authority and educational ethics is therefore a key ethical challenge.

6.1. *Data-driven*

The truth of the development of technology is not contrary to the educational origin, as shown in the study of Wang, N et al. Generative Adversarial Networks in Deep Learning is the basis for the construction of GenAI technology, which helps to obtain applications and updates in all types of scenarios. It is pointed out that in future research, generative AI is combined with tools such as CiteSpace in order to provide a more comprehensive service [45]. Bahroun, Z. et al. designed an AI system to support assessment, personalized learning and intelligent tutoring based on the PRISMA framework. Special emphasis was placed on interdisciplinary collaboration and application of technology. In the system, the AI chatbot real-time response and feedback process performed well and assessment accuracy was guaranteed. Incorporating chatbots into language teaching can take into account the optimization of learning days, which can improve diverse language skills [46]. Dwivedi, R et al. explored research on generative AI using literature, text analysis, and social network analysis. It was found that previous research gathered on deep neural networks and related techniques, in the long run, social network analysis may be generalized in generative AI on a large scale, and safety, reliability, and level of trust are the main directions for future AI development [47].

Generative AI facilitates human-computer interaction centered on non-deterministic problems, and enhanced data-driven can create a different generative learning experience compared to ordinary search engines.

6.2. *Policy Development*

Generative AI brings expectations and risks to education, and examining generative AI in educational change from a developmental perspective not only provides insight into its inherent dichotomous and unifying connections, but also anticipates the inevitable trend of building a community of destiny with education. Bukar, U. A. et al. address the ethical issues of generative AI in education by utilizing a hierarchical analysis approach to build a decision-making framework for regulating and reviewing chatbots [48]. Giannakos, M. et al. address the need for generative AI to perform various types of tasks, pointing to the need for insights into the roles that can be played by human experts, strong and sustained evidence, human-centered technology design, necessary policies, and support and competence mechanisms in further research. To this end, the ecological dimension, ethical and pedagogical soundness of generative AI can be guaranteed [49].

In conclusion, as long as the human-machine relationship in education is properly handled and a common value, code of conduct and path of action are adhered to, the construction of a human-machine community of destiny will surely become a new goal for the future development of education.

7. **Conclusion**

This paper searches for related research and finds that at this stage, generative artificial intelligence can realize the role of teaching and learning support, feedback learning and assessment. Engineering thinking, computational thinking, design thinking, and systems thinking are analyzed and elaborated, and the cultivation of generative AI for enlightened thinking ability is examined, and how universities can respond to generative AI. The challenges of generative AI, including expertise gaps and uncertainty of generated content, as well as common ethical issues, are also analyzed at the levels of decision-making, management, academics, and safety, which help to better grasp the future direction of generative AI in education. This study involves generative AI in the smart classroom and enlightened thinking, focusing on the overall analysis, while the discussion of some key and difficult areas, such as the assessment of academic integrity and information security protection, is not in-depth, and the issue of its ethical and moral code has not yet been addressed, which can be followed by further in-depth exploration around these topics.

Funding

This work is supported by Anhui Provincial Scientific Research Plan Preparation Project 2024AH052311/2022AH053070.

This work is supported by 2023 China University Industry-University-Research Innovation Fund 2023RY026.

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