ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202606_9(6).0019

Research on Generative Artificial Intelligence in Education -- A Visualization Analysis Based on CiteSpace

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Abstract

In recent years, artificial intelligence technology has developed rapidly, and generative AI technologies, led by ChatGPT, have been increasingly applied and developed in the field of education. By conducting a visual analysis of the development of generative AI technology in education, this study aims to provide references and insights for subsequent in-depth research and research trends.This study employs bibliometric methods and utilizes CiteSpace software to conduct a visual analysis of journals related to generative AI and education published on China National Knowledge Infrastructure (CNKI) from 2023 to January 2025.The results indicate that, in terms of the volume of literature, research on generative AI in education is still in its early stages. Researchers are primarily concentrated in the education sector within universities, and collaboration between researchers and research institutions remains insufficient. Regarding research hotspots, "artificial intelligence," "higher education," and "educational transformation" are currently prominent areas of focus. Accordingly, this paper offers further conclusions and reflections to provide guidance for in-depth research, practical exploration, and progress in the application of generative AI within the education sector.

Keywords

Generative AI; ChatGPT; Education; Bibliometrics.

1. Introduction

Generative AI technologies, led by ChatGPT, are accompanied by continuous exploration and practice. ChatGPT (full name: Chat Generative Pre-trained Transformer) is a chatbot program developed by OpenAI and released on November 30, 2022.ChatGPT is an AI-driven natural language processing tool capable of generating responses based on patterns and statistical regularities observed during the pre-training phase. It can interact based on the context of a conversation, engaging in dialogue that truly mimics human communication, and can even perform tasks such as drafting emails, video scripts, copywriting, translation, coding, and writing academic papers. This technology promotes improvements in educational quality and enhances learners' learning abilities and overall literacy.Over the past 100 years, the introduction of new technologies into education has consistently sparked intense debate and widespread concern. In fact, the adoption of educational technology has always been met with various concerns and controversies. During this century, we have witnessed numerous applications and transformations in educational technology, including blackboards, projectors, computers, the internet, and tablets—and ChatGPT is certainly no exception [1].Given the rapid

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202606_9(6).0019

development and widespread adoption of ChatGPT, it is necessary to explore the research emerging in the field of education.

Consequently, this study utilizes Cite Space to conduct a visual analysis of the literature on generative artificial intelligence in the field of education. By examining multiple dimensions—including the volume of publications, research institutions, authors, and research hotspots—we aim to facilitate further development in this field and provide effective, valuable references and insights for future research and practice.

2. Data Sources

2.1. Data Sources

All data in this paper are sourced from China National Knowledge Infrastructure (CNKI). The search period spanned from January 10, 2023, to January 15, 2025. Literature was selected using the "Advanced Search" function, with subject terms limited to relevant keywords such as "generative AI technology," "ChatGPT," "education," and "learning." After manually screening documents relevant to this study, a total of 198 valid papers were identified. Given that this field of research is still in its early stages and relatively new, with a short time span and a limited number of studies, this research has certain limitations.

2.2. Research Methods and Tools

This study employs two methods to examine the current state of generative AI in education. First, bibliometric analysis is used to statistically analyze and objectively evaluate research on generative AI in education in China, focusing on publication volume, research institutions, and authors. Second, visual analysis is conducted using CiteSpace software to map a knowledge graph of the retrieved literature, providing an in-depth analysis of current research through keyword co-occurrence and keyword emergence diagrams.This study explores the current research hotspots and trends regarding generative AI technology in China's education sector.

3. Results Analysis

3.1. Analysis of Publication Volume

Statistical analysis of journal literature on generative AI in education in China reveals that, since generative AI (ChatGPT) was released on November 30, 2022, related research is still in its preliminary exploratory phase; consequently, relevant literature began to appear only after January 2023. The total number of published papers is 308. However, as the application of generative AI technology gradually expands, the number of users is increasing, and related research is also growing steadily.With the government's rational promotion of AI technology and the continuous improvement of relevant policies and laws, it is believed that research and applications of generative AI in China's education sector will continue to deepen in the future. Both theoretical and applied research on generative AI will increase, leading to a rise in the number of publications.

3.2. Analysis of Authors

Analyzing the publication records of the researchers in these papers provides insight into the scholars involved and allows for a continuous understanding of research trends within the field through their research activities. The top four authors by publication volume are Yu Hao, Wang Youmei, Wang Hongcai, and Jiao Jianli. The most prolific scholar is Yu Hao from Shaanxi Normal University, who published four papers in a single year. His research focuses on future teacher competencies, artificial intelligence, digital literacy, and educational informatization.Ranked second is Wang Youmei from Wenzhou University, whose research focuses on educational informatization, knowledge construction, digital literacy, and digital learning. Wang Hongcai

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from Xiamen University focuses on educational research, higher education, innovation and entrepreneurship education, and the learning society. Jiao Jianli from South China Normal University primarily researches educational digital transformation, digital technology, artificial intelligence, and educational informatization.

The author network diagram generated by the CiteSpace tool provides insight into the collaborative relationships among different scholars (see Figure 1 below). As shown in Figure 1, the nodes in this network are relatively dispersed, with only a few nodes connected to one another. Researchers such as Wang Youmei and Wang Dan from Wenzhou University collaborate within the same institution, so they have some connections. Most researchers, however, operate in isolation, lacking a sense of collaboration and teamwork.

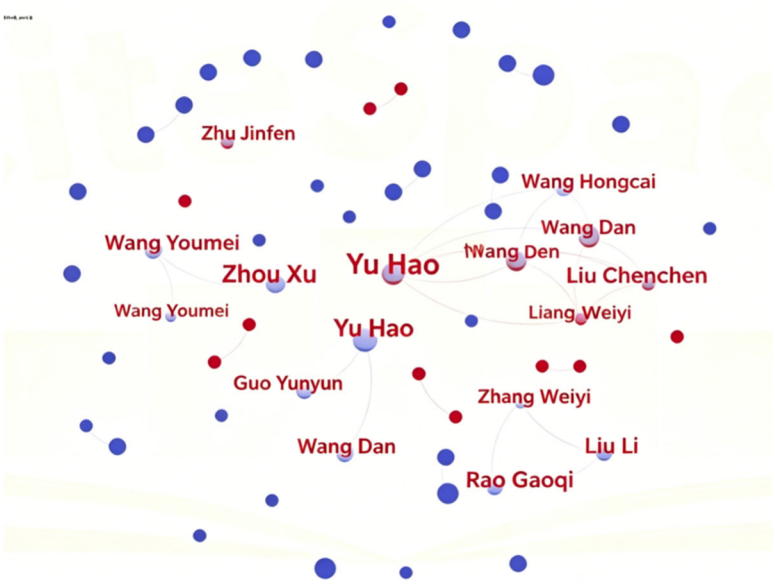

Figure 1. Author Network Diagram

3.3. Analysis of Publishing Institutions

Analysis of the publishing institutions reveals that East China Normal University ranks first in publication volume with 19 papers (see Table 1 below). This university has conducted extensive research on generative AI in the field of education. The primary research institutions include East China Normal University, Shaanxi Normal University, and Beijing Normal University (see Figure 2 below). As shown in Figure 2, collaboration among these institutions is insufficient, indicating room and potential for further cooperation.Most of these are teacher training universities, indicating that research on generative AI technology is receiving significant attention in the education sector. Further analysis reveals that the majority of core research institutions are independent education research departments within universities. It is evident that education research departments in universities under the direct jurisdiction of the Ministry of Education are better able to focus on their specific research directions, yielding more significant research outcomes, and can to some extent guide provincial universities to continue deepening their research in this field [2].

These research institutions should increase mutual exchange and collaboration. Establishing information-sharing mechanisms—through the sharing of data, resources, and research findings—will promote cooperation and exchange among research institutions, thereby strengthening collaborative relationships. This will drive research institutions at various levels to produce high-quality research outcomes within a broader platform and scope.

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Table 1. Top 10 Research Institutions by Number of Publications

No.	Research Institution	No.	Research Institution
1	East China Normal University	6	Southwest University
2	Beijing Normal University	7	South China Normal University
3	Central China Normal University	8	Xinjiang Normal University
4	Shaanxi Normal University	9	Beijing Language and Culture University
5	Northeast Normal University	10	Shenzhen University

Figure 2. Network Map of Publishing Institutions

3.4. Analysis of Publishing Institutions

By analyzing keyword co-occurrence, we can identify the associations between the themes, topics, and keywords in these documents. This information helps us gain a deeper understanding of current research hotspots in generative AI within the education sector, uncover patterns and trends, and thereby provide researchers with further insights and discoveries (see Figure 3 below). In this study, keywords were selected as nodes to conduct keyword co-occurrence analysis on the literature data.Keyword centrality is a crucial metric in co-citation network analysis (see Table 2 below). Through keyword centrality analysis, core keywords within the network can be identified; these keywords represent high importance and influence within the network. This helps researchers discover key topics or hot areas within the network, enabling them to pinpoint significant topics and focal points. It provides an important reference for researchers to make more scientific decisions and formulate strategies for subsequent research.

3.4.1. Sub-section Headings

Analysis of keyword frequency data reveals that although keywords such as “artificial intelligence,” “higher education,” “educational reform,” and “human-machine collaboration” were not search terms, they rank high in frequency. This indicates that research on generative AI in the field of education is primarily associated with these areas. It also suggests that these fields are interrelated; by drawing on each other’s strengths and addressing weaknesses, research can become more scientific and comprehensive, thereby promoting improvements in teaching efficiency and quality within the education sector.

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3.4.2. Keyword Centrality Analysis

Analysis of keyword centrality data reveals that the keyword "artificial intelligence" has a relatively high centrality value and a high frequency of occurrence, indicating that it is a hot research topic in the education sector. As a major focus in the field of artificial intelligence, generative AI—with ChatGPT as its primary representative—has seen widespread application. A large number of large language models are being utilized, and their advantages in terms of enhanced intelligence and interactivity are being leveraged across various fields. The education sector also hopes to leverage such tools to promote educational development.

3.4.3. Frequency and Centrality Analysis

Analysis of the relevant data reveals discrepancies between certain keywords and their centrality rankings. For instance, keywords such as "higher education," "educational reform," and "human-machine collaboration" have centrality values of 0.03, 0.04, and 0.03, respectively. This suggests that these research topics play a significant role in studies on generative AI in education; however, their low frequency indicates that they have not yet received sufficient attention from researchers.

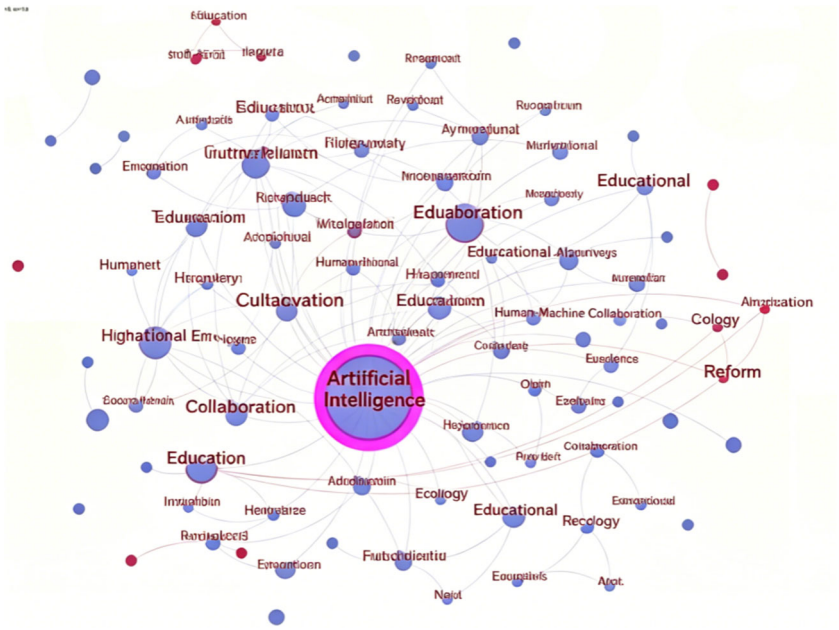

Figure 3. Keyword Co-occurrence Map

3.5. Keyword Clustering

Two metrics require attention in the keyword clustering network diagram: the Q-value and the S-value. These metrics characterize the quality of the clustering. Generally, it is considered that: Modularity: Cluster module value (Q-value); generally, Q > 0.3 indicates a significant clustering structure.Silhouette: The average silhouette value (S-value) of the clustering. It is generally accepted that S > 0.5 indicates a reasonable clustering, while S > 0.7 implies a convincing clustering. Analysis of the keyword clustering results (see Figure 4 below) shows that the Q-value is 0.5723, indicating that the keyword clustering results are significant. The S-value is 0.8962, suggesting that the keyword clustering is convincing.

3.5.1. Artificial Intelligence

Cluster 0, "Artificial Intelligence," is the largest cluster, containing keywords such as "educational reform," "educational technology," and "educational ethics." Research in this area primarily focuses on the broad intersection of artificial intelligence and education. In her discussion on how education should address artificial intelligence, Gu Xiaoqing proposed that education must prioritize cultivating humans' ability to pose questions and generate innovative

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202606_9(6).0019

ideas.We must focus on the fundamental basis of human intelligence, emphasizing the cultivation of humans' ability to pose questions and generate new ideas, thereby better developing human intelligence, nurturing qualified talent, and driving the progress of human society; we must enhance human emotional intelligence and creativity, promote active adaptation to continuously changing and complex unknown environments, and flexibly leverage one's own initiative and creativity to achieve the transformation and innovation of the world and the self [3] .From an international perspective, Xia Qi drew on application approaches from various academic disciplines abroad, which may include scenarios such as self-directed learning, collaborative learning, and inquiry-based learning. She proposed strategies such as cultivating students' AI literacy and implementing dual oversight of technology and regulations [4]. These researchers have all proposed corresponding strategies for the development of AI-enabled education from different angles. All emphasize the cultivation of learners' own abilities from a "human-centered" perspective, ensuring that imagination and creativity are not constrained.

3.5.2. Human-Machine Collaboration

Cluster 1, "Human-Machine Collaboration," includes keywords such as "talent development," "educational transformation," and "future education." As evident in Li Zhengtao's conference review "ChatGPT and Future Education," the deep integration of generative AI with future education will reshape the forms of human education and learning, alter the historical narrative of education, inspire future educational transformation, and influence educational research.The impact of generative AI, exemplified by ChatGPT, on education heralds the emergence of a new type of hybrid educator. This will drive a reshaping of the underlying logic of future education, a shift toward a symbiotic educational ecosystem, and a transformation of academic production scenarios. It is proposed that we should approach the educational implications of ChatGPT with scientific rationality, philosophical scrutiny, and a clear sense of values [5].With the advancement of technology, an increasing number of tools designed to facilitate learning will be adopted, and educational formats will become increasingly diverse. It is therefore necessary to adopt a dialectical perspective and engage in rational reflection within this context of deep integration to better leverage the potential of these tools.

3.5.3. Risks and Challenges

Cluster 2, "Risks and Challenges," includes keywords such as "educational innovation," "educational risks," and "digital literacy." This section of the research primarily addresses the unknown challenges of artificial intelligence and how to mitigate the ethical risks it poses.Based on concerns regarding potential breaches of academic integrity, imbalances in educational assessment mechanisms, insufficient ethical awareness, and limitations in knowledge levels associated with AI, Wang Youmei proposes developing assessment strategies, reshaping academic integrity, and clarifying the relationship between humans and tools. Educational administrators should establish reasonable policies and standards to coordinate the relationship among students, teachers, and technological tools, thereby fostering a positive and healthy teaching environment [6].Yang Zongkai leverages ChatGPT to empower teaching by focusing on "Teaching": constructing a diversified, intelligent, and comprehensive teaching system; "Learning": creating ubiquitous, personalized, and collaborative learning models; and "Education": reshaping the essence of education to prioritize knowledge as a foundation, competence as a focus, and values as a priority [7]. He also proposes strategies such as enhancing ideological awareness, promoting applied research, and accelerating disciplinary development.Based on his technological philosophy of the "other-self" relationship, Zhang Jingwei argues that in educational applications, ChatGPT's "otherness" must be confined to specific parameters, particularly requiring careful scrutiny of AI-generated content and materials used in teaching.We must be vigilant against technology's potential to constrain

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students' cognitive content and modes of understanding, while emphasizing diverse forms of cognition and the non-deterministic nature of problem-solving. The ethics of ChatGPT's educational application must be premised on the unity of technological intentionality and educational purpose, supporting teaching to maintain focus on the student's learning process and safeguard inductive thinking, while remaining vigilant against the impact of ChatGPT—as an "other"—on the development of students' agency [8].Technology is a double-edged sword; while scientific and technological advancements have brought numerous conveniences and progress to humanity, they have also introduced negative impacts and challenges. Therefore, we must maintain rationality and caution when utilizing science and technology to avoid their abuse or malicious exploitation.

By adhering to the ethical and moral standards of science and technology, we can maximize their positive impact while mitigating their negative effects, thereby achieving a harmonious coexistence between science and technology and society.

3.5.4. Higher Education

Cluster 4, the "Higher Education" category, includes keywords such as "application scenarios" and "knowledge revolution."Gao Qiqi argues, from the perspective of the revolution in knowledge content production, that this alienation manifests across three dimensions: micro, meso, and macro. From a micro perspective, general-purpose large models directly influence learners through rote output, which not only distorts the spirit of education but also leads to a superficial cognitive structure and homogenized thinking among learners. This results in a shallow and mediocre understanding of education rather than a deeper one, ultimately precipitating a crisis of educational vulgarization.From the meso-level perspective, within the usage context of general-purpose large language models, there is a tendency for educational participants to become physically disengaged. This shifts the focus of education toward the relationship between technology and humans, making it difficult to establish genuine human-to-human connections. A significant tension arises between the intimacy with machines and the alienation from people, which may ultimately lead to a crisis of the loss of the learning community.From a macro perspective, the conversational learning characteristics of general-purpose large language models may lead to risks such as the collapse of educational values, the rise of new digital authorities, and the colonialization of platform capital consciousness, ultimately exposing the entire educational system—and even society—to a new ideological crisis [9]. Therefore, it is necessary to adopt measures dialectically according to different contexts to promote the positive development of artificial intelligence technology and provide better support for the advancement of education.

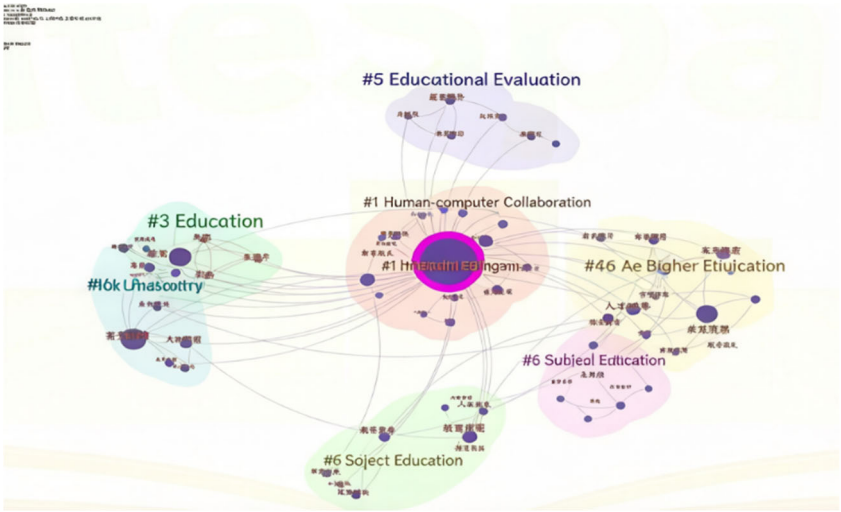

Figure 4. Keyword Clustering Diagram

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202606_9(6).0019

4. Research Summary

Statistics on the number of publications indicate that, given the relatively short history of generative AI applications, research on generative AI in the field of education is still in its infancy. Relevant applied research remains insufficient, with most studies focusing on theoretical discussions. In terms of publishing institutions, research is primarily conducted by universities; however, collaboration among them is still limited, and no effective collaborative organizational structure has yet been established. As for researchers, collaboration between them is also rare, with only a small number of scholars from the same university working together.Researchers also focus on different fields. From the perspective of keyword co-occurrence, “artificial intelligence,” “higher education,” and “educational reform” are currently the main research hotspots. The application of new technologies is always a process of gradual exploration. The application of generative AI in education—whether positive or negative—must be viewed dialectically, and appropriate measures must be taken. How to effectively utilize the technology to maximize its benefits while mitigating adverse effects is an ongoing process of exploration.

4.1. Research Reflections

Research on generative AI in the field of education is still in its early stages of development and exploration. Researchers and research institutions operate relatively independently and in isolation, with little collaboration among them. This hinders the exchange and dissemination of information. Therefore, academic activities such as conferences, lectures, and workshops should be held regularly to provide a platform for scholars to exchange ideas and collaborate. Jointly writing papers and publishing research findings can strengthen cooperative relationships and enhance academic influence.Research institutions should actively seek partners to establish long-term collaborative relationships, including partnerships with other research institutions, universities, enterprises, and government departments, to jointly undertake research and collaborative projects. Regularly organizing academic exchange events on relevant topics and exhibitions showcasing the outcomes of collaborative research projects will create a synergistic force, fostering a favorable environment for research in this field.

Analysis of the literature reveals that concrete examples of generative AI applications in education remain scarce, with most research still conducted from a macro perspective. Beyond higher education, generative AI’s capabilities in knowledge integration and emotion recognition can also be explored in K-12 education. Across different disciplines and educational levels, generative AI technology can facilitate teaching and learning, better empowering learners to take a central role in their education.Content-generating AI products are fundamentally driven by the goal of simulating human interaction, directly addressing humanity’s most basic needs, and thus represent the most down-to-earth products in the AI field. It is foreseeable that many research and development institutions will continue to launch new natural language processing products based on diverse rules and algorithmic models.Current products still have shortcomings, such as simple formats and a lack of emotional expression. However, it is further foreseeable that future products will not be limited to text formats but may also incorporate images, animations, audio, or video, and may even include other as-yet-unknown formats, potentially integrating emotional elements [10].Well-designed products contribute to the advancement of education. By leveraging generative AI tools, teaching and learning gain new possibilities, leading to a more comprehensive enhancement of learners’ abilities and competencies. It is believed that through continuous research and exploration, generative AI technology can be better applied to the field of education, paving the way for new breakthroughs.

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