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Reviewing Researches on Artificial Intelligence—Driven Education and Teaching from 2014 to 2023: A CiteSpace-based Visual Analysis

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Abstract: *In the current digital era, the field of education is undergoing unprecedented changes. Artificial Intelligence (AI), as a revolutionary technology, has demonstrated its unique advantages in various fields such as healthcare, finance, and manufacturing. To explore the application of AI in education and teaching, as well as its evolving trends, we analyzed 1364 CSSCI papers from the China National Knowledge Infrastructure (CNKI) database from 2014 to 2023. Employing bibliometrics and knowledge mapping methods, we established a detailed view of the development trends and research hotspots in AI-driven education and teaching research. The Citespace software was employed for visual analysis of critical data such as authors, institutions, and keywords, including the collaboration networks of authors and institutions, keyword frequency and centrality, and the evolution of research topics. Our analysis revealed that AI-driven education and teaching research from 2014 to 2023 can be divided into three developmental stages: nascent (2014–2016), rapid development (2017–2019), and stable development (2020–2023). What's more, we identified close cooperation among core institutions and authors, determined multiple hotspot topics in AI within education and teaching, and revealed the developmental trajectory of these topics.*

Keywords: *Artificial Intelligence; Education; Teaching; Visual Analytics; CiteSpace*

1. Introduction

With the advent of the information technology era, human lifestyles have undergone profound transformations. Particularly, the rapid development of artificial intelligence (AI) has significantly impacted people's work, life, and learning methods. In the healthcare sector, AI technology is used for precise diagnoses and the creation of personalized treatment plans[1]. In the financial industry, AI assists in analyzing market trends and individual investment behaviors, providing customized financial services[2]. Additionally, in manufacturing, AI enhances efficiency and productivity, reducing downtime through predictive maintenance [3]. In the field of education, the application of AI is also becoming a vital force in driving educational development and innovation[4]. The Chinese government has implemented a series of policy measures to promote the integration of artificial intelligence and education. For example, "China's Education Modernization 2035" and the "14th Five-Year Plan" explicitly state the need to strengthen the application of cutting-edge technologies like AI in education and to promote the informatization of education [5].

The development of AI has also led to a transformation in the approach to talent cultivation. Traditional educational models are being replaced by more personalized and adaptive learning methods that can adjust to students' individual learning habits and abilities[6]. Technological advancements, particularly breakthroughs in machine learning, data mining, and natural language processing, have introduced new teaching methodologies and learning tools to education. For instance, by analyzing students' learning data through AI, educators can more effectively identify students' weaknesses and strengths, thereby providing more tailored teaching support[7]. Nonetheless, the application of artificial intelligence in education also faces several challenges and issues, such as data privacy protection, the technological adaptability of teachers and students, and balancing the roles between machines and human educators[8]-[10].

To comprehensively understand the themes and development trends of research in education and teaching driven by artificial intelligence, this study aims to systematically review AI-driven education

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and teaching-related papers published in CSSCI journals from 2014 to 2023. Utilizing bibliometrics and knowledge mapping methods, we conduct statistical analysis on the publication dates and institutional distribution of the literature in this field. This analysis reveals the publication volume of authors and their collaboration patterns. Additionally, through cluster analysis, centrality analysis, timezone co-occurrence analysis, and keyword emergence analysis, we visually present the related research themes, hotspots, and their evolutionary trends. The study delves deeply into how artificial intelligence impacts and transforms the modalities and strategies of education and teaching.

In summary, this study aims to deeply analyze how artificial intelligence plays a role in transforming the educational environment and enhancing educational quality. At the same time, it identifies existing problems and challenges, with the hope of providing guidance for future research and practice in education and teaching driven by artificial intelligence.

2. Data Sources and Research Methodology

2.1. Data Sources

Using CNKI as the data source, the journal selection was limited to CSSCI to enhance data quality. Advanced search queries were created by combining the primary keyword, "Artificial Intelligence," with the secondary keywords, "Education," "Teaching," and "Talent Cultivation," using a "Logical AND" operation. On November 25, 2023, a search was conducted for literature from 2014 to the search date, using the title of the papers. The search results were sorted by download count. After excluding duplicate papers and non-academic documents, a total of 1364 papers were obtained.

2.2. Research Methodology

Quantitative analysis was conducted using bibliometrics and knowledge mapping methods to visually present the focal content of research in education and teaching driven by artificial intelligence, exploring the interconnections among papers and the development trajectory of related research. Basic statistical analysis of the documents was performed using the CiteSpace software, revealing the publication dates of research findings in the field, author publication volume, and institutional publication volume. Visualization tools were used to construct author collaboration networks, keyword co-occurrence networks, keyword co-occurrence time zones, key terms burst tables, and institutional collaboration clusters. This approach clarifies the characteristics, hotspots, development trends, and frontiers of research in education and teaching driven by artificial intelligence.

3. Basic Statistical Analysis

3.1. Temporal Distribution

Publication volume was analyzed annually, and the trend from 2014 to 2023 is illustrated in Figure 1. The journey of research in education and teaching driven by artificial intelligence can be broadly divided into three phases: the germination period (2014–2016), the boom period (2017–2019), and the stabilization period (2020–2023). During the Germination Period, artificial intelligence began to emerge in the field of education and teaching, but the volume of publications was relatively low, marking the early stage of exploring how to apply AI technologies in education. The boom period saw a significant increase in publication volume, indicating widespread interest and research in AI in the field of education. In the Stabilization Period, the volume of publications continued to grow, albeit at a slower pace, signifying a more stable phase of development in the field with sustained research interest.

These data indicate that research on artificial intelligence in the field of education has undergone a progression from an initial stage to rapid growth and then to stable development. This suggests a broad prospect for the application of artificial intelligence in education and teaching, with researchers showing keen interest in this area. It also implies that research activities in this field are likely to continue.

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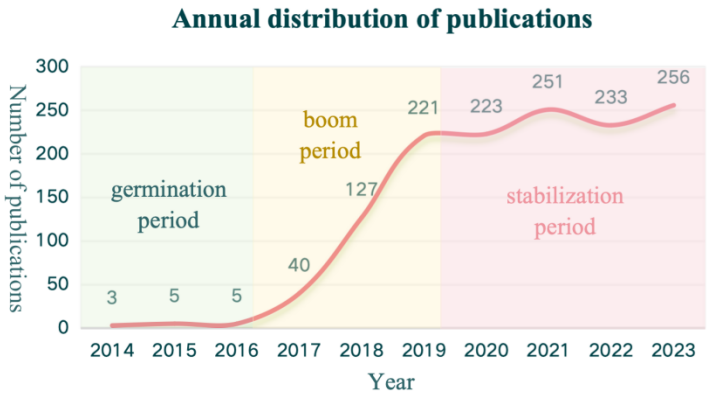

Figure 1: Annual distribution of publications.

3.2. Institutional Distribution

Institutions with a high volume of publications in a field are considered core-leading institutions[11]. In the field of education research driven by artificial intelligence, a total of 269 institutions have published papers, with the top 10 publishing institutions, shown in Table 1, predominantly being teacher education universities. 'Centrality' represents the centrality of an institution. A value greater than 0.01 indicates a core institution, and the higher the centrality, the more significant the institution's influence in the field. Notably, the Department of Educational Information Technology at the Faculty of Education, East China Normal University, has a centrality of 0.12, and the Faculty of Education at Beijing Normal University has a centrality of 0.11, both relatively high. These institutions account for 16.06% of the total publication volume. The Department of Educational Information Technology at East China Normal University and the Faculty of Education at Beijing Normal University are tied for the highest publication volume. East China Normal University, with its departments featuring prominently in the top ten, holds a dominant position in related research. Additionally, the Faculty of Education at Southwest University, the School of Information Technology in Education at South China Normal University, the School of Education at Tianjin University, the College of Information Science and Technology at Northeast Normal University, and the Department of Educational Information Technology at the Faculty of Education, East China Normal University also have more than 15 publications each, contributing significantly to the field and leading the way.

Table 1: The top 10 organizations in terms of the number of publications.

Institutions	Number of Publications	Centrality	Percentage
Department of Education Information Technology,East China Normal University	35	0.07	2.57%
Faculty of Education,Beijing Normal University	35	0.11	2.57%
Faculty of Education,Southwest University	25	0.04	1.83%
Faculty of Education,East China Normal University	21	0.12	1.54%
School of Information Technology in Education SCNU	20	0.02	1.47%
School of Education,Tianjin University	19	0	1.39%
School of Education Science,Nanjing Normal University	17	0.06	1.25%
East China Normal University	16	0.01	1.17%
College of Information Science and Technology, Northeast Normal University	16	0.01	1.17%
Department of Educational Information Technology,Faculty of Education,East China Normal University	15	0.02	1.10%

The publication data of institutions were clustered, and the results are illustrated in Figure 2. The clustering diagram reveals three major collaborative relationships among institutions: cluster #0 in red, dominated by the Department of Educational Information Technology at East China Normal University; cluster #1 in green, led by the Faculty of Education at Beijing Normal University; and cluster #2 in purple, centered around the School of Humanities and Social Sciences at Beijing Institute of Technology. The clustering results are tied to geographic locations: institutions in the red cluster #0 are all located in

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Shanghai; the green cluster #1's institutions are in Beijing and Jiangsu; and the purple cluster #2's institutions are all in Beijing, indicating that high-tech publication institutions, such as those involved in artificial intelligence, are situated in more technologically advanced regions. Moreover, institutions with a high volume of publications often act as leaders of their respective collaborative clusters.

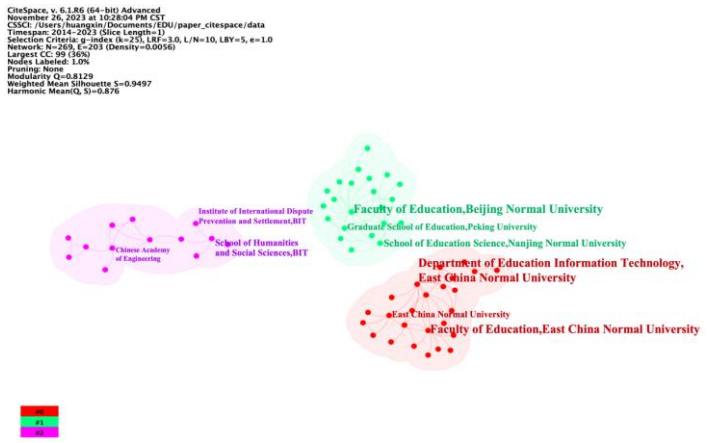

Figure 2: Clustering of issuing institutions.

3.3. Author Analysis

3.3.1. Analysis of Author Publication Volume

Price's Law describes that within any given scientific discipline, only a small number of researchers contribute the majority of publications. Core authors are identified according to Price's Law[12]. The minimum publication volume formula for core authors is:

$$M = 0.749N_{max}^{1/2} \quad (1)$$

The formula, where M represents the minimum number of publications by major contributors, and N_{max} is the publication volume of the most prolific author in the field.

According to the statistical results, the author with the highest number of publications in the field of education and teaching driven by artificial intelligence is Xiaoqing Gu, with a total of 31 publications, hence N_{max}=31,The calculation yields M≈4.17, indicating that authors with at least 4 publications in this field are considered core authors, totaling 37 individuals. The list of core authors in this field is shown in Table 2, and their publication volume accounts for 17.08% of the total.

Table 2: Core author statistics.

Author	Number of Publications	Year	Author	Number of Publications	Year
Xiaoqing Gu	31	2021	Dang Wang	5	2022
Shijin Li	13	2021	Haifeng Li	5	2018
Jin Liu	11	2019	Yonghe Wu	5	2017
Leilei Zhao	11	2021	Honglin Wu	4	2019
Zhiting Zhu	8	2017	Haoxiang Hou	4	2019
Youqun Ren	8	2016	Hongxiu Li	4	2020
Xudong Zheng	8	2016	Ruihua Dai	4	2020
Xiangjun Hao	8	2021	Wei Wang	4	2018
Ronghuai Huang	8	2019	Jiyu Jia	4	2018
Qiong Wang	6	2021	Xin Yang	4	2021
Wengjing Lv	6	2017	Ye Xu	4	2018
Xuesong Zhai	5	2022	Xiaoyong Hu	4	2022
Lei Yuan	5	2020	Qinxiao Hu	4	2020
Baichang Zhong	5	2020	Qinhua Zheng	4	2016
Kai Liu	5	2018	Wunong Zhang	4	2020
Youmei Wang	5	2020	Sannvya Liu	4	2021
Jing Du	5	2018	Dejian Liu	4	2017
Chenchen Liu	5	2020	Shaochun Zhong	4	2020
Lihui Sun	5	2019			

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3.3.2. Analysis of Author Collaboration

An author collaboration network was constructed to analyze the collaborative relationships among researchers in this field. As shown in Figure 3, the size of the nodes is proportional to the authors' influence, and the thickness of the lines represents the strength of collaboration. The colors of the nodes and lines correspond to the years indicated in the legend. The largest node, Xiaoqing Gu, predominantly displays deep orange, orange, and light yellow, which, according to the timeline at the bottom, indicates that the main collaborations occurred in recent years. The surrounding nodes also exhibit similar colors, suggesting these collaborations were formed in the same period. The author collaboration network reveals that the field of education and teaching driven by artificial intelligence has established several relatively fixed research groups. In the diagram, the Xiaoqing Gu node is large, indicating close connections with the associated authors, Xiangjun Hao and Shijin Li. We can see that Jing Du and Ronghuai Huang have many connections around their nodes, with thicker or more numerous lines to Xiayu Yin, Dejian Liu, Wei Zhou, and Haijun Zeng, indicating frequent collaboration among them. On the right side of the graph, Youmei Wang, Chenchen Liu, and Dan Wang have formed a stable triadic relationship. Additionally, other authors typically collaborate in pairs or work independently.

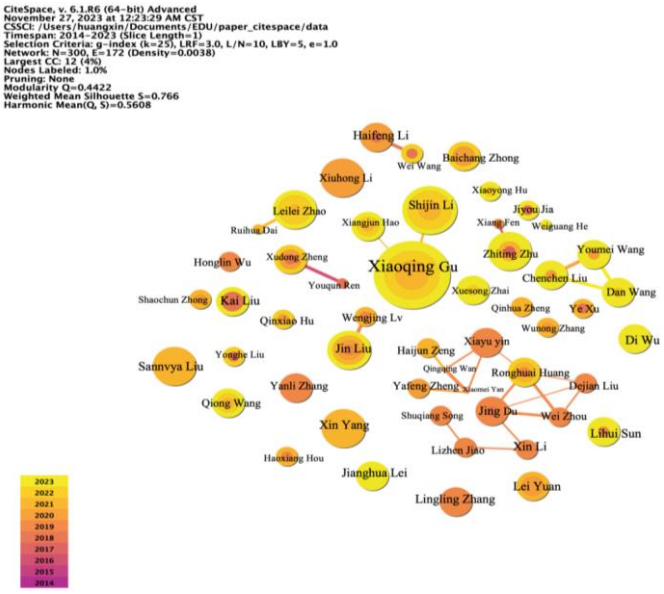

Figure 3: Analysis of Author Collaboration.

3.4. Analysis of Research Hotspots

3.4.1. Thematic Cluster Analysis

By utilizing the CiteSpace software for keyword clustering analysis, sample data were imported, and the time slicing was set to one year. The Pathfinder algorithm was used to prune the network graph, retaining only effective paths among all possible ones, with the clustering analysis results shown in Figure 4. The generated keyword cluster map represents the hot topics and trends in the field's literature, with each numbered cluster representing a research theme, composed of frequently occurring keywords within the literature. According to the clustering results, there are 11 main categories of themes in the field of education and teaching research driven by artificial intelligence. Here is an overview of each theme:

#0 Artificial Intelligence: Research under this theme primarily defines the concept of AI, reviews its current development status, and explores its applications in education and teaching, including intelligent teaching systems, learning analytics, adaptive learning environments, etc.

#1 Talent Cultivation: This research focuses on the patterns, methods, and content of talent cultivation in universities, especially the cultivation of students' ideological and political education, innovation ability, and critical thinking, as well as how the education system can adapt to these needs.

#2 Intelligent Education: The theme focuses on the intelligence of educational technology, discussing how technologies like AI can be applied in university teaching to carry out intelligent instruction and form an intelligent education community, such as using data mining to optimize the learning process or

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personalize learning paths.

#3 Big Data: This theme explores the application of big data analysis in educational decision-making, learning behavior analysis, and the improvement of educational outcomes.

#4 Educational Application: This theme researches how various educational applications, tools, and platforms support learning and teaching.

#5 Deep Learning: The theme is related to processing educational data with deep learning algorithms, as well as students' deep learning experiences and methods.

#6 Education: A broad theme that includes research on educational theories, practices, and policies.

#7 Vocational Education: This theme explores the vocational education system, skill training, and market adaptability.

#8 Learning Analytics: The theme focuses on learning analytics, personalized learning, and educational data mining, considering individual differences and improving the learning process and environment by analyzing learning data.

#9 Innovation: The theme involves strategies for educational innovation, including the development of new teaching methods and learning models.

#10 Online Learning: This theme examines the effectiveness and strategies of online education platforms, MOOCs, and distance learning.

#11 Digitalization: The theme focuses on the digital transformation of education, including the integration of digital resources and technologies, combining modern technology with traditional education to advance the modernization of higher education.

From the clustering results, the modularity value Q is 0.6361, which is high. A high modularity index indicates the presence of relatively independent research theme groups within the network. A value greater than 0.3 suggests a clear modular or group structure within the network, signifying that the clustering structure is significant. The weighted average silhouette coefficient S is 0.8884, an indicator of clustering quality. A value closer to 1 and above 0.5, indicates that the clustering results are quite reasonable, with high similarity within keywords and good clustering quality. N is 410, indicating that there are 410 independent keywords in the keyword co-occurrence network. The number of links E is 705, meaning there are 705 connections between keywords. Density is a measure of network compactness, with an overall network density of 0.0084. This low value suggests that the network is not very dense and the structure is loose, implying that the connections between keywords are not very tight. In other words, scholars have a rich array of perspectives in their research on education and teaching driven by artificial intelligence and are not focused on a very limited number of research themes.

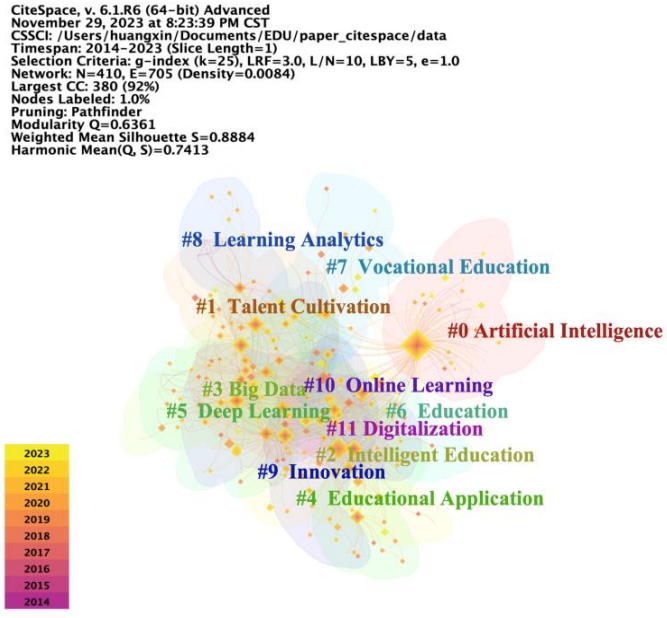

Figure 4: Keyword clustering.

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3.4.2. Keyword Frequency and Centrality Analysis

Keywords with high frequency and substantial centrality are considered hot topics in the research field[13], where high-frequency keywords represent the core of the research and high-centrality keywords signify the focus of the research. An analysis of frequency and centrality was conducted on keywords in the field of education and teaching research driven by artificial intelligence. Keywords with a centrality of 0.01 or higher were selected, and they were ranked by frequency. The top 20 results are shown in Table 3.

Table 3: High frequency and high centrality keywords.

Keyword	Frequency	Centrality	Year
Artificial Intelligence	825	1.49	2016
Talent Cultivation	66	0.04	2015
Intelligent Education	57	0.07	2018
Big Data	53	0.04	2017
Higher Education	50	0.02	2017
Smart Education	48	0.04	2016
Education	41	0.01	2018
Human-machine Coordination	39	0.02	2018
Deep Learning	31	0.03	2017
Educational Change	25	0	2017
Future Education	23	0.01	2018
Educational Application	21	0.04	2017
Educational Technology	20	0.02	2016
Vocational Education	19	0	2019
Teacher Education	18	0	2019
Machine Learning	17	0.02	2017
New Engineering	17	0.01	2017
Age of Intelligence	17	0.03	2019
Learning Analytics	16	0.04	2014
educational ethics	12	0.01	2020

From the cluster analysis and the analysis of keyword frequency and centrality, it is evident that over the past decade, the hot topics in research on education and teaching driven by artificial intelligence have primarily focused on using AI and big data technologies to optimize higher education teaching models and talent cultivation mechanisms. The key research emphasis has been on integrating AI technology into the educational process to innovate teaching methods, enhance teaching efficiency, and provide customized learning solutions tailored to individual students' needs. This includes applying learning analytics to understand and improve learning outcomes, exploring the application of intelligent education in classroom teaching, and developing education tools and platforms related to deep learning. Additionally, the research also concentrates on how to cultivate future-required skills and competencies through technological means, such as machine learning and human-computer collaboration. Overall, AI-driven education research aims to deepen the application of educational technology and promote the innovation of teaching strategies to meet the educational demands of the digital age.

3.4.3. Theme Evolution Analysis

In CiteSpace, the log-likelihood ratio algorithm was selected to conduct an evolutionary analysis of the research data, resulting in Figure 5, which depicts the co-occurrence time zone map of hot topics in education and teaching research driven by artificial intelligence. Each node in the graph represents a keyword, with the node size reflecting the frequency of the keyword's occurrence, and the lines indicating the co-occurrence relationships between keywords. The colors represent different time periods, showing the emergence and evolution of various research themes. Based on this co-occurrence time zone map and the clustered keywords, we can analyze the relevant hot topics and their developmental trends over time. The first six themes are analyzed as follows:

#0 Artificial Intelligence: This is the most prominent theme in the research, spanning 2016-2023. This theme's research continues to deepen and expand, showing artificial intelligence as a persistent and evolving research topic. The graph reveals a rich array of keywords related to AI, covering educational governance, classroom teaching, digital innovation, rural education, metaverse, etc. The research encompasses various applications of AI in education, including innovations in teaching methods,

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improving learning efficiency, and optimizing the allocation of educational resources. The focus of AI research has evolved over time, shifting from basic theoretical exploration to the integration of specific applications and practices.

#1 Talent Cultivation: Spanning 2014-2023, this theme focuses on how the education system adapts to technological developments, particularly in vocational education and technical skills education, and how to effectively cultivate talents with AI technology to meet future challenges. This includes professional education, skill development, and cultivation of innovative capabilities.

#2 Big Data: Spanning 2016-2023, the timeline for this theme closely aligns with that of artificial intelligence. Keywords related to big data became particularly prominent around 2017. As data technology has evolved, the application of big data in educational research has deepened. This theme involves keywords like intelligent education, machine learning, deep learning, knowledge graphs, cloud computing, etc. In the era of big data, with exponential data growth and changes in thinking and lifestyle, new educational perspectives have emerged. Various branches have started to appear, such as the modernization of education governance mechanisms driven by big data[14], and research on the directions and pathways for educational innovation in the era of artificial intelligence. The research focuses on how big data is applied in education and how it assists educators and policymakers in making educational decisions, teaching reforms, and analyzing learning behaviors.

#3 Higher Education: Starting early in the timeline and continuing to recent years, this theme focuses on how AI and big data technologies are applied in higher education to improve educational quality and management. In the later part of the timeline, the theme showed a stronger development, focusing on how the higher education system adapts to the new challenges of AI and big data, emphasizing educational quality and management, and seeking opportunities for enhancement with new technologies.

#4 Intelligent Education: Spanning from 2016 to present, prominent keywords include educational technology, computational thinking, educational ethics, digitalization, intelligent technology, etc. This theme focuses on the fusion of technology with educational practice, particularly in enhancing learning experiences and teaching efficiency, involving the development of intelligent educational tools and platforms, and how these technologies optimize teaching and learning processes and their potential impact on education.

#5 Educational Research: Spanning 2018-2023, this theme reflects continuous academic exploration, focusing on educational theories, methodologies, evaluation, technical ethics, subjectivity, etc., reflecting ongoing exploration and development in educational research methods, theories, and technologies.

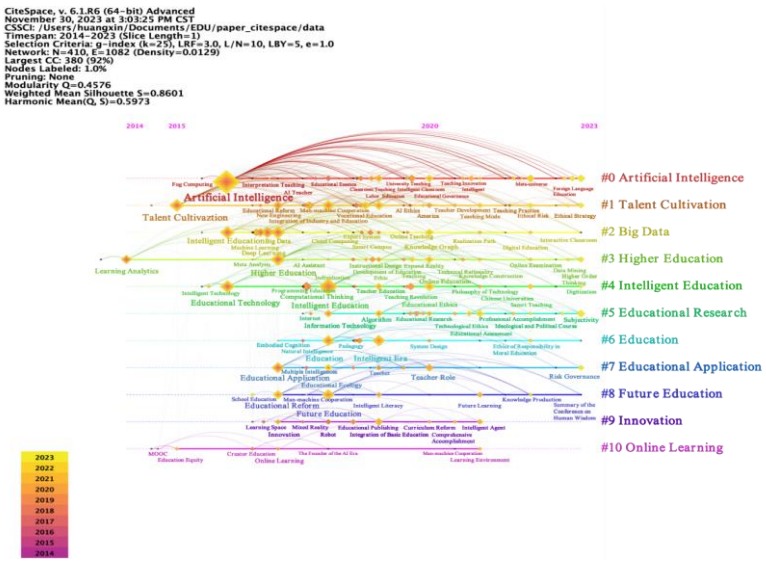

Figure 5: Keywords co-occurring time zone map.

3.4.4. Frontier Analysis

Emerging dynamics in a research field can reflect the forefront of study, revealed through term bursts[15], identifying terms with high frequency change rates within a specific time period. Using CiteSpace to analyze emerging terms, the 12 keywords with the highest burst strength were identified, sorted by the year of burst initiation, as shown in Figure 6. 'Terms' refers to the emerging keywords;

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'Year' indicates the year in which the term first appeared in the data; 'Strength' represents the burst strength of the term, where a higher Strength value indicates a higher intensity of emergence, suggesting that the keyword is likely to be a research hotspot in this field during that time; 'Begin' is the year when the burst started; 'End' is the year when the burst ended. The blue color on the right represents all years, while the red in each row indicates the duration from the beginning to the end of the burst for each key term.

Figure 6: Top 12 terms with the strongest citation bursts.

From the burst graph, it is known that the top 12 terms with the strongest citation bursts are Learning Analytics, Individualized Learning, Deep Learning, Educational Informationization, Artificial Intelligence + Education, Adaptive Learning, Computational Thinking, Reform, Talent Cultivation, Teacher Role, and Age of Intelligence. The term with the highest burst intensity, emerging from 2017 to 2018, is "Deep Learning", reflecting the high level of attention to the application of deep learning technology in the field of education, closely related to the application of artificial intelligence in education. Next, "Learning Analytics" had a long period of emergence, starting in 2014 and continuing until 2018, indicating significant attention to the application of this technology in the educational sector. Moreover, "Age of Intelligence" began emerging in 2019 and continued through 2023, with its sustained burst intensity indicating that the impact of intelligent technology in modern society has become a long-term research trend. Interestingly, in the Age of Intelligence (2019-present), "Reform", "Talent Cultivation", and "Teacher Role" have also emerged as hot topics with high burst intensities. We speculate that, influenced by the rapid development of intelligent technologies, especially the empowerment of artificial intelligence in education, scholars are paying more attention to educational reform, talent cultivation, and rethinking the role of teachers driven by intelligent technology.

In addition to the aforementioned key emergent terms, other emerging terms such as "ChatGPT" and "Large Models" also appear in subsequent rankings. These emerging terms are of particular interest and warrant further exploration in future studies.

The emergence of these key terms not only reveals the importance and timeliness of various research topics but also reflects the process of adaptation and integration of emerging technologies in the field of education. This trend is likely to continue influencing the future direction of educational research and practice.

4. Conclusions

By conducting a bibliometric and visual analysis of 1364 CSSCI-certified papers in the field of education and teaching driven by artificial intelligence, published between 2014 and 2023 in the China National Knowledge Infrastructure (CNKI) database, the main development stages, key research institutions and authors, as well as research hotspots and trends in this field were revealed. The results show:

In the basic statistical analysis, through the distribution over time, this study found that research on artificial intelligence in the field of education experienced a process from an initial germination stage to a rapid development period, and finally entered a stable development phase. Starting in 2014, research on artificial intelligence in education and teaching gradually caught the attention of the academic community and showed an increasing trend year by year. Particularly from 2017 to 2019, research in this field grew rapidly, becoming a hot topic in academia. This was followed by a more mature and stable phase of development.

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In the analysis of institutional participation and distribution, the institutions involved in research on education and teaching driven by artificial intelligence are primarily concentrated in higher education institutions, particularly normal universities and comprehensive technical universities. These institutions play a leading role in research in the field of AI in education, highlighting the importance of universities in advancing research in this area. In the analysis of the geographical distribution characteristics of institutions, it is evident that the leading institutions in this research field are mostly located in economically and technologically advanced regions. This may be related to the strong research infrastructure, financial support, and technological resources available in these areas. Through the analysis of collaborative networks, we found that there are close cooperative relationships between research institutions. This collaboration often spans different disciplines and fields, promoting the sharing of knowledge and resources, and enhancing the comprehensiveness and innovation of research.

Through author analysis, as of 2023, a preliminary core group of authors, consisting of 37 scholars with significant contributions in this field, has been identified. Although a core group of authors and some stable research teams have been established, the cooperative relationships among researchers are not yet fully developed. There are still a large number of independent researchers working in this field, indicating that the field is in a phase of exploration and growth. This stage may be accompanied by the discovery of new research directions and the establishment of new collaborative relationships, providing diversified possibilities and opportunities for the future development of this field.

In terms of thematic clustering and evolution analysis, this study identified several hot topics in the field of education and teaching driven by artificial intelligence through the analysis of keyword frequency and centrality, keyword co-occurrence time zone maps, and emergent term charts. The research field has gradually shifted from exploring basic AI theories and discussion of application methods to broader and more in-depth studies, such as learning analytics, personalized teaching, and educational policy. Over time, the research field continues to expand, covering cutting-edge topics such as intelligent education systems, educational data analysis, and the integration of AI technology with traditional teaching methods. A series of emerging themes have also appeared, such as educational big data, computational thinking, and online learning. Lastly, we believe that the application of artificial intelligence in the field of education will continue to deepen in the future, and its impact on educational strategies and practices will become more significant. Researchers and educational practitioners should pay attention to these developing trends and actively explore how artificial intelligence can more effectively promote innovation in learning and teaching.

As artificial intelligence technology continues to develop and be applied, research in the field of education is gradually transitioning from a rapid development phase to a stable development phase. In the future, research in this field may focus on the application of AI technology in higher education and online education, while also paying attention to how AI technology can enhance educational quality and efficiency, and address emerging educational challenges, such as remote teaching and the need for personalized learning. At the same time, it is important to pay attention to some emerging terms that are currently not widely recognized but are showing signs of emergence, such as large models and ChatGPT, and actively explore these areas.

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