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Original Paper

Research Progress and Trend Analysis of "Artificial Intelligence +" Education

-- Visual Analysis Based on CiteSpace Knowledge Graph

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Abstract

With the rapid development of artificial intelligence (AI) technology, its application in the field of education has gradually gained popularity. Based on the CiteSpace visual knowledge graph analysis method, this paper makes a systematic visual analysis of the core literatures on artificial intelligence collected by CNKI from 2018 to 2023 in terms of the number of publications, authors, institutions, keyword co-occurrence, clustering and emergence. The analysis results show that in the past six years, the research in the field of "artificial intelligence + education" is in a prosperous period, and the current research hotspots are mainly focused on the application scope of artificial intelligence in the field of education, the impact of artificial intelligence on education and the development direction of artificial intelligence in the field of education in the future. The practical focus of "artificial intelligence + education" mainly focuses on labor education and the cultivation of students' labor literacy.

Keywords

Artificial intelligence, CiteSpace, Knowledge graph, Visual analysis

1. Introduction

The term "artificial intelligence" originated from the Dartmouth College conference in 1956, and has developed into a cutting-edge interdisciplinary science involving computer science, information science, psychology, philosophy, cognitive neuroscience, physiology and many other fields (Xu & Wang, 2009). Its main goal in the near future is to use machines to imitate and execute some intelligent functions of human brain. And develop related theories and technologies (Zhang & Zhang, 2017).

By summarizing and combing the existing literature, we can find that some scholars have analyzed this

issue. For example, Jia Jiyou (2018) analyzed the relationship between artificial intelligence and education from the essential characteristics of education and the research field of artificial intelligence, and expounded the positive impact of artificial intelligence on education. Scholars Cui Jingui and Ma Yingying (2023) reviewed the research progress of artificial intelligence education from three aspects: basic problem research, two-way enabling research and technology application, and proposed prospects for the future application of artificial intelligence in the field of education. Scholars Zhang Kunying and Zhang Jialian systematically discussed the "new area", "misunderstanding", "blind area" and "forbidden area" existing in the application or research of artificial intelligence in education and their causes, and discussed some countermeasures and suggestions for the application of artificial intelligence in education [5]. From the perspective of ethical governance, scholar Bai Junyi proposed the realistic challenges and realization paths of artificial intelligence in the field of education.

However, most of these literatures are in the form of text, and there are few comprehensive analyses on the current research status of artificial intelligence in the field of education and frontier hot spots. Therefore, this paper takes the core literature related to "artificial intelligence + education" in CNKI as research samples, summarizes the research status of artificial intelligence in recent years, and analyzes the current research hot spots. In order to lay a foundation for future related research.

2. Research Design

2.1 Research Method

Using CiteSpace as a research tool, this paper makes a systematic visual analysis of the relevant core literature on artificial intelligence in CNKI, so as to intuitively show the progress and frontier trends of artificial intelligence research in the field of education, so that we can more clearly predict the future development trend of artificial intelligence in the field of education.

2.2 Data Source

In this paper, CNKI was selected as the data source, the subject term of the search was "artificial intelligence + education", the time span was "2018-2023", the journal sources were selected as SCI and CSSCI, and after eliminating invalid data with low relevance to the subject, a total of 233 valid papers were selected.

2.3 Research Procedure

In this study, the selected literatures were first exported from CNKI, processed by CiteSpace's data format converter, and then imported into CiteSpace to generate the atlas. In CiteSpace, set the time period to 2018-2023, time slice to 1 year, node type to Keyword, and select the clipping method of Pathfinder to generate the correlation graph.

3. Analysis of Research Status in the Field of "Artificial Intelligence + Education"

3.1 Publication Volume Analysis

Comprehensive statistics on the change of the number of literatures can help us better understand the

current research situation, and is of great significance for predicting the future development trend. According to the statistics of the 233 selected literatures, the research status of "artificial intelligence + education" can be obtained, as shown in Figure 1 below.

As shown in the figure, the number of papers published by artificial intelligence in the field of education from 2018 to 2023 shows an overall upward trend. In 2018, the number of core papers was 8, accounting for about 3.4% of the total number of papers, while in 2023, the number of core papers was 74, accounting for about 31.6% of the total number of papers. The number of published papers has decreased, only 18, but the overall trend is still rising, indicating that the current research on artificial intelligence in the field of education still has a high heat.

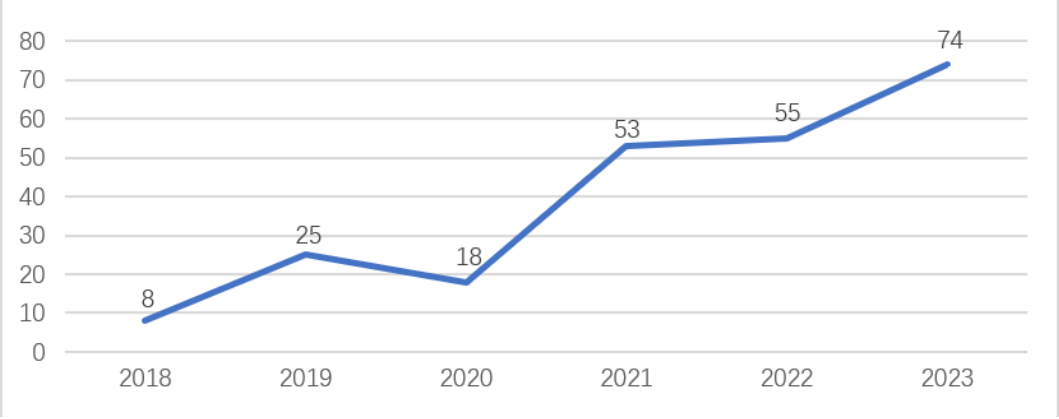

Figure 1. Time Distribution of Literatures Related to "Artificial intelligence + Education"

3.2 Author Analysis

The author was analyzed by CiteSpace software, and the top 6 authors of "artificial intelligence + education" in China were counted, as shown in Table 1. As can be seen from the table, the author with the most published papers is Gu Xiaoqing, who has published 11 papers in the past six years. Followed by Wu Yonghe and Zhao Leilei, the number of papers was 5 and 4 respectively; Three scholars, Lv Kaiyue, Wu Di and Liu Jin, have published three papers.

Table 1. Author's Number of Publications

Serial number	Number of published papers	Year of earliest publication	author
1	11	2021	Gu Xiaoqing
2	5	2018	Wu Yonghe
3	4	2022	Zhao Leilei
4	3	2019	Lv Kaiyue
5	3	2023	Wu Di
6	3	2020	Liu Jin

As can be seen from the author co-occurrence graph (Figure 2), there are fewer connections among authors on the whole, indicating that the cooperation between authors is not much and is more dispersed. However, as can be seen from the amplified co-occurrence map of authors (FIG. 3), several research groups have initially formed in this field, which are represented by three research groups: Gu Xiaoqing - Du Hua - Li Shijin - Liu Yan、Wu Yonghe - Chen Xu – Wu Di - Li Huan - Bai Qingchun - Ni Qin、Zhao Leilei - Dai Ruihua - Zhang Li - Zhao Keyun - Wu Xiaofan.

Figure 2 .Author Co-occurrence Map

Figure 3. Enlarged Author Co-occurrence Map

After the above analysis, we can conclude that only a few authors have formed academic research groups, but most scholars are still in the state of independent research, which indicates that the exchange and cooperation of scholars in the field of "artificial intelligence + education" needs to be

further strengthened.

3.3 Analysis of Issuing Institution

The number of documents issued by the issuing institution is counted, as shown in Table 2 below. Table 2 lists the top seven publishing institutions, from which it can be concluded that the Department of Educational Information Technology of East China Normal University ranks first in the number of publications, with a total of 10 core papers published in the past six years. It was followed by the Faculty of Education of Beijing Normal University, the Faculty of Education Information Technology of South China Normal University, the Faculty of Education of Central China Normal University, the Faculty of Education of Southwest University and the Faculty of Education of East China Normal University, each with six core papers, and the last was the China National Institute of Education Sciences, with five core papers.

Through statistical analysis, it is found that the research field of "artificial intelligence + education" is mainly led by high-level universities, and the research departments are mainly concentrated in the Department of Education Information Technology, the Department of Education, and the Institute of Education Science, etc. The research focuses on the interdisciplinary fields of educational theory and education management, computer software and computer application, and digital library. It shows that "artificial intelligence + education" is not only limited to the level of education, but also applied to other levels of society.

Table 2. Analysis of the Number of Issuing Institutions

Serial number	Number of issued documents	Date of earliest publication	Issuing agency
1	10	2021	Department of Educational Information Technology, East China Normal University
2	6	2020	Faculty of Education, Beijing Normal University
3	6	2020	School of Educational Information Technology, South China Normal University
4	6	2020	School of Education, Central China Normal University
5	6	2019	Faculty of Education, Southwest University
6	6	2018	Faculty of Education, East China Normal University
7	5	2018	Chinese National Institute of Education Sciences

In CiteSpace software, the time slice was set to 1 year, the node type was set to "Institution", the cutting method of Pathfinder was selected, and other Settings remained unchanged. The co-occurrence map of the publishing institution was obtained, as shown in FIG. 4 below. As can be seen from the figure, the relationship between most of the publishing institutions is relatively scattered, but there are also a few

cooperative relationships among them, such as the Communication College of Qufu Normal University, the School of Education of Jiangnan University, the Faculty of Education of East China Normal University, the Faculty of Education of Southwest University, and the Southwest Ethnic Education and Psychology Research Center of Southwest University. Shanghai Intelligent Education Research Institute of East China Normal University, Department of Education Information Technology of East China Normal University, Shanghai Open Education Distance Education Engineering Technology Research Center of Shanghai Open University, Faculty of Artificial Intelligence Education of Central China Normal University and Faculty of Education of Henan Normal University have close cooperation; Beijing Normal University, China National Institute of Education Sciences and Beijing Normal University China Basic Education Quality Monitoring Collaborative Innovation Center have formed a relatively close cooperative relationship.

After the above analysis, it can be found that only some institutions in the field of "artificial intelligence + education" have formed cooperative relationships, while most other institutions are still in the state of independent research, which indicates that the connection between institutions in the field needs to be further strengthened.

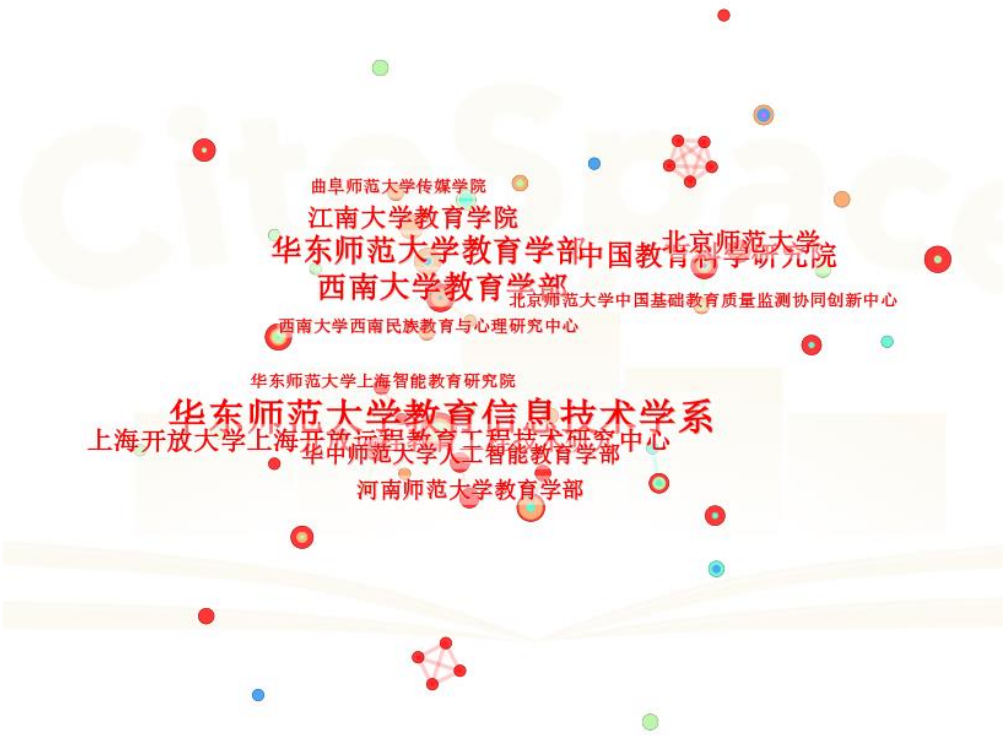

Figure 4. Co-occurrence Map of Issuing Institutions

4. Analysis of Research Hotspots and Trends in the Field of "Artificial Intelligence + Education"

4.1 Keyword Co-occurrence Analysis

CiteSpace software was used to display nodes in annual ring style, and the keyword co-occurrence map

was obtained, as shown in Figure 5. Among them, the ring represents the knowledge circle with high frequency keywords as nodes, and the size of the ring represents the number of nodes contained in the ring; The connection line represents the degree of correlation between nodes, and the denser the connection, the greater the degree of correlation between nodes. The size of the word represents the frequency of keyword occurrence, and the larger the font, the higher the frequency of keyword occurrence (Lv & Zhang, 2019). As can be seen from the graph, the research in the field of "artificial intelligence + education" in China presents the characteristics of more small nodes and close connections between nodes.

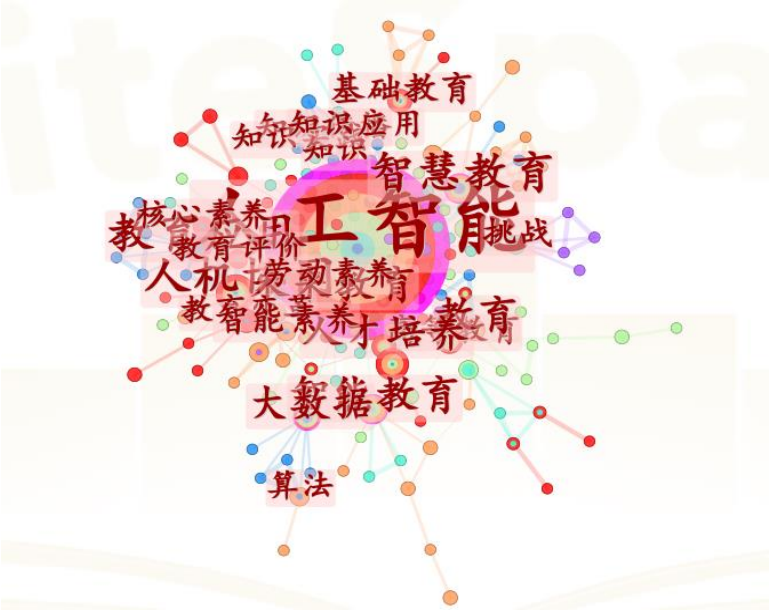

Figure 5. Keyword Co-occurrence Map

CiteSpace software also provides words with high occurrence in the selected literature, that is, keywords with high frequency. Keywords with more than 5 occurrences are shown in Table 3. Intermediary centrality is an index used to measure the importance or influence of nodes in the network. The greater the intermediary centrality, the stronger its influence. Ranking the intermediary centrality of high-frequency keywords in Table 3, the top 6 are artificial intelligence (1.77), intelligent education (0.14), intelligent education (0.13), big data (0.13), man-machine collaboration (0.10) and educational application (0.10).

As can be seen from Table 3, the field of application of artificial intelligence has penetrated into basic education and higher education; The fields of concern mainly focus on future education, intelligent education, intelligent education and teacher education; There is also human-machine collaboration and the combination of big data; The research direction of "artificial intelligence + education" has penetrated into the level of educational reform, educational application and talent training, which indicates that the research scope in this field is very extensive and has been carried out more deeply.

Table 3. Keyword Frequency Table

Serial number	Frequency of occurrence	Intermediation centrality	Year of earliest occurrence	keyword
1	191	1.77	2018	Artificial intelligence
2	12	0.10	2019	Man-machine collaboration
3	9	0.02	2019	Teacher education
4	8	0.03	2018	Future education
5	7	0.14	2020	Intelligent education
6	7	0.13	2018	Wisdom education
7	6	0.13	2019	Big data
8	6	0.06	2018	education
9	6	0.08	2021	Higher education
10	5	0.03	2019	Educational reform
11	5	0.10	2019	Educational application
12	5	0.02	2021	Personnel training
13	5	0.07	2019	Basic education

4.2 Key Words Cluster Analysis

Keyword cluster analysis is mainly to cluster keywords into different categories by weighing the correlation degree and affinity degree of subject words, so as to determine the evolutionary relationship of various knowledge structures in the research scope and corresponding research hotspots, etc., so as to deeply explore the research frontier and research hotspots (Wei, 2018). In CiteSpace software, node types are set as keywords, and LLR algorithm is used for cluster analysis to generate keyword clustering map, as shown in Figure 6.

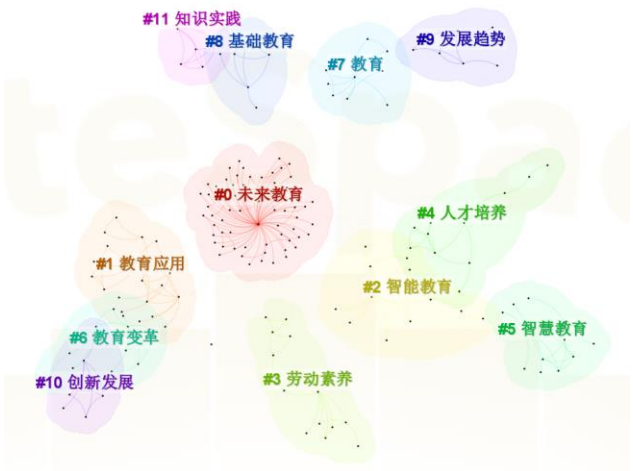

Figure 6. Keyword Clustering Diagram

Based on the analysis of Figure 6, keywords in the field of "artificial intelligence + education" can be summarized into three themes, which are respectively the application scope of artificial intelligence in the field of education, the impact of artificial intelligence on education and the development direction of artificial intelligence in the field of education in the future, as shown in Table 4.

Table 4. Summarizes the Themes

Serial number	Outline the theme	Clustering keywords
1	Scope of application of artificial intelligence in the field of education	Smart education (#2), Labor literacy (#3), Smart education (#5), Education (#7), Basic education (#8)
2	The impact of artificial intelligence on education	Educational application (#1), Talent Training (#4), Educational Reform (#6), Innovative development (#10), Knowledge practice (#11)
3	Future development direction of artificial intelligence in the field of education	Future education (#0), Development trend (#9)

The first is the application scope of artificial intelligence in the field of education, which can be seen that it has penetrated into basic education. Gu Xiaoqing and other scholars have discussed the development index of intelligent education, including the connotation, framework and measurement (Li, Gu, Li et al., 2023), and Professor Zhu Zhiting has also systematically discussed the theory and practice of intelligent education as well as the future development trend (Zhu, Lu, Wang et al., 2019). Scholar Wang Huiying (2021) discussed the transformation and implementation path of labor education in the era of artificial intelligence. It can be seen that the application of artificial intelligence in the field of education is relatively extensive, and some scholars have elaborated on a specific aspect, indicating that the development of artificial intelligence in the field of education is becoming deeper.

The second is the impact of artificial intelligence on education, which has not only produced a lot of educational applications, but also caused educational reform, making the country's training of talents more multi-faceted and advanced, and various forms of artificial intelligence have gradually changed the way students learn knowledge. Guo Wenming's (2023) comparative analysis on the history of educational reform The topic of future education change is put forward, which indicates that artificial intelligence has had a profound impact on our education field and continues to push education forward.

Finally, the development direction of artificial intelligence in the field of education in the future is discussed. Scholar Gu Xiaoqing (2023) has made a prospect of future education and proposed that future education will focus on the comprehensive development of human beings and strengthen the unique intelligence of human and machine. Scholar Cui Xiangping (2002) has made a detailed analysis

of the trend of combining artificial intelligence with teaching research and explained the existing problems. All these show that artificial intelligence has a certain positive effect on the future education, and can be concretely applied to the actual teaching.

4.3 Keyword Emergence Analysis

Emergent analysis is to probe the rise or fall of a certain keyword or subject word through the change of literature citations in a certain interval. Through the emergence analysis of the keywords in the field of "artificial intelligence + education" in the past six years and setting the threshold as 0.1, the top six keywords can be obtained as follows: smart education, education, teachers, future education, labor literacy and labor education, as shown in Figure 7.

Figure 7. Keyword Emergence Results in the Field of "Artificial Intelligence + Education"

As can be seen from Figure 7, the two keywords of "smart education" and "education" in 2018-2019 have high emergent values, indicating that scholars are mainly discussing how to integrate "artificial intelligence" into education to form "smart education". The emergent value of "teachers" and "future education" in 2020-2021 ranks in the forefront, indicating that scholars are empowering "artificial intelligence" in teachers, promoting the landing of "artificial intelligence + education", and thinking about the possible development of future education; The emergence of the two sudden words "labor literacy" and "labor education" in 2021-2023 indicates that scholars have begun to pay attention to a specific aspect of students' core literacy, aiming to cultivate students' labor literacy, which indicates that the research field of "artificial intelligence + education" has been very detailed and penetrated into basic education.

5. Conclusion and Prospect

5.1 Research Conclusion

CiteSpace software was used to analyze 233 core literatures on "Artificial intelligence + Education" from 2018 to 2023, and the following conclusions were drawn:

First of all, from the point of view of the number of documents, the current research on "artificial

intelligence + education" in our country is still in a prosperous stage, the number of documents is generally on the rise, and it still has a high research heat.

Secondly, it can be seen from authors and institutions that, on the whole, the connection between authors and institutions is relatively scattered. Only a small number of scholars and universities have formed research groups, but most of them are still in the state of independent research, and there is less cooperation between them.

Finally, it can be seen from the graph of keyword co-occurrence, clustering and emergence that the current research hotspots focus on the application scope of artificial intelligence in the field of education, the impact of artificial intelligence on education and the development direction of artificial intelligence in the field of education in the future, and the practical focus is mainly on labor education and the cultivation of students' labor literacy.

5.2 Research Prospect

In summary, we can see that the application of artificial intelligence in the field of education is very extensive, not only basic education, but also higher education and vocational education, and many scholars have discussed the development trend of artificial intelligence in the field of education in the future, although there will be some difficulties in the application process, but we must face the difficulties and fully meet the arrival of the era of artificial intelligence!

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