

A Review of Research on the Impact of Artificial Intelligence on Learning

-- Based on Citespace Knowledge Mapping Analysis

Ting Mei¹, Lingyun Yuan^{1,2}, Chenglong Li¹

¹ School of Information, Yunnan Normal University, Kunming 650500, China

² Key Laboratory of Ethnic Education Informatization of the Ministry of Education, Yunnan Normal University, Kunming 650500, China

Abstract

The application of artificial intelligence technology in education has penetrated into various fields of education and teaching, scientific research and social services, and the relationship between artificial intelligence and education and teaching has become a hot research topic. With the development of information and communication technology, the research on the impact of AI on learning has also had some theoretical and empirical results and presented many trends and problems. In this paper, we intend to statistically analyse 500 papers during the period of 2010-2023 by means of keyword analysis, author analysis and research institution analysis. It is found that in recent years, domestic artificial intelligence is mainly in the fields of learning science, machine learning, deep learning and higher education, etc. Artificial intelligence has had a profound impact on education and learning, which not only changes the way of learning, but also promotes the change of education.

Keywords

Artificial Intelligence; Learning; Visualisation; Citespace.

1. Introduction

In recent years, the application of artificial intelligence (AI) technology in various fields has become more and more extensive, and the development of AI has gradually penetrated into the field of education and teaching, which has a greater and greater impact on learners. The research and application of AI in the field of education, on the one hand, is to promote the further improvement of the quality of education and teaching, and on the other hand, is also to better use robotics, intelligent robots and other AI technologies to serve education. In a sense, deep learning, machine learning, and higher education are all typical intelligent education and teaching modes. Therefore, the study of the impact of AI technology on learning will further promote the high-quality development of education. Currently, research on AI and learning has achieved fruitful results in the academic world.

Artificial Intelligence (AI) mainly studies how to use computers to simulate human thinking processes and intelligent behaviours, with the aim of exploring the laws of human intelligent activities. At present, artificial intelligence in education in China is still in its infancy and still faces many difficulties. This bibliometric review counted 500 articles published in academic and professional journals from 2010 to 2023, and the scope of the study was limited to the Chinese literature provided by online scientific databases, indexed by the Science Citation Index Expanded (SCIE) and the Social Science Citation Index (SSCI).

"Artificial Intelligence + Education" resulting from the combination of Artificial Intelligence and education has become a new business and a new mode in the field of education in China [1]. In

searching the field of artificial intelligence, the keywords with the highest frequency are learning science, deep learning, machine learning, etc. In the era of "Internet +", the development of artificial intelligence has become an inevitable trend in education and teaching, and is also a key element in promoting the leapfrog development of education [1]. The combination of artificial intelligence and education has a broad prospect and practical significance. The impact of AI on learning will directly promote the modernisation process of higher education in China, and at the same time, it is also an opportunity to change the evaluation method of colleges and universities, which is of great practical significance. In this paper, we use CiteSpace software as a tool, bibliometrics, visual analysis and other methods and means to sort out the knowledge map of higher education management and evaluation from the aspects of theme progression, hot spot focus, key figures and disciplinary crossover, etc., and reveal the current research status, development status and disciplinary crossover trend of this field through the drawing of the knowledge map [2]. Through clustering analysis and emergence analysis of keywords, the research hotspots of AI in the field of education and teaching are clarified; the development trend of AI on learning is deeply analysed; and the contents and objectives of the study are systematically elaborated on this basis.

2. Status of Research

Artificial intelligence in the field of education and teaching has continued to heat up in recent years, and the impact on learning is one of the current research hotspots. Learning influences is a complex system engineering, with systematic, complex, dynamic and other characteristics [1]. How to analyse the impact of AI on learners' learning in the field of education and teaching is an important problem to be solved. Among them, the hot research on learning influencing factors mainly involves the aspects of talent cultivation, discipline construction, and teacher training[1]. Literature on learning influences mainly focuses on education journals. With the development of new technologies, computer science and technology have been gradually applied to various disciplines and achieved certain results. For example, in the theory and practice of higher education, how to use computers to simulate human behaviours in order to manage, control and evaluate them is also one of the hot issues in current research[2]. The scholars who have published a large amount of literature on the impact of artificial intelligence on learning and have a certain degree of representativeness are the Department of Educational Technology of Huazhong Normal University and the Department of Education of Beijing Normal University[2]. At present, the research on the application and mechanism of the impact of artificial intelligence on learning is more extensive, from the "artificial intelligence +" empowered education to education big data, deep learning and other artificial intelligence education research is more abundant, domestic scholars mainly from the following aspects of the corresponding research[2]:

- (1) On the impact of artificial intelligence application in the field of education on learning;
- (2) Analysis of the current status and future development trend of research in the field of artificial intelligence in China.

Globally, the United States is the country that pays the most attention to the development of AI technology and its related applications with the most extensive and active research [2]. Through the analysis of education big data of major universities or research institutions at home and abroad, it is found that: the U.S. has the most abundant research results in AI, which are applied in many fields such as higher education reform and development and higher education evaluation; the U.S. universities have more research results in the field of AI, which are mainly concentrated in the construction of scientific research platforms, development of scientific research projects, popularisation of science, education, and cultivation of students' innovation ability; and there are a certain number of explorations in the field of education

evaluation in the United States. In addition, the United States also has a certain amount of exploration in the field of education evaluation [1]. China's research on the application of AI technology in higher education started late, and the number of relevant papers and academic results are not rich enough. From an international perspective, there are some related topics or theoretical explorations in the fields of education and teaching, learning influences, and so on. In this study, we selected 500 articles from the CNKI literature, and used CiteSpace 6.2.1.1 to search the literature. CiteSpace 6.2.R4 was used to analyse the literature for the period of 2010-2023. Cluster analysis of the literature using keywords, research institutions, etc. According to the CiteSpace knowledge map, the time nodes of the research on AI and education teaching in China's higher education field are 2018, 2020 and 2023, of which there are fewer relevant documents before 2016, and the hotspots of the research are mainly concentrated in the fields of education information development, big data analysis and mining, etc. [2]. Since 2016, with domestic and foreign research institutions conducting a lot of practical research and policy exploration on the use of AI in education and teaching, scholars at home and abroad have begun to study the impact of AI on learning from the "wisdom" [2]; 2018 and 2019 are two milestone nodes, marking the beginning of the development of AI in China, and the beginning of the development of AI in education and teaching. The years 2018 and 2019 are two milestones that mark a long period of exploration and practice of AI in education in China [3].

3. Visualisation and Analysis of Results

The database used in this paper is China Knowledge Network (CNKI), and the keywords of "artificial intelligence", "learning" and "impact" were used to search the journals published in the period from 2010 to 2023. Using "artificial intelligence", "learning" and "impact" as keywords, we searched the journals published between 2010 and 2023, and found a total of 3398 articles, of which 1355 articles had a citation frequency of ≥ 10 . Firstly, from the perspective of time distribution, the literature retrieved by CNKI has the problems of weak continuity between years, large fluctuation in the number of articles published in each year, and small number of articles published in individual years.

Secondly, CiteSpace is a visual analysis tool based on scientometrics, whose main functions include: counting, analysing and discovering topics of relevant literature in a subject area, revealing the trajectory and trend of topic evolution, and the number of highly cited literature within a specific period of time (e.g., between years)[4]. Prior to the emergence of this tool, researchers mainly used keyword co-occurrence networks to analyse the links between the literature in the research field. The co-occurrence network used in

The co-occurrence network used in CiteSpace consists of a large number of nodes (links), and the links between the nodes represent the relationships between the nodes[4]. Therefore, CiteSpace software is also called "linkage mapping" or "co-occurrence analysis", which is based on the literature, and through the interconnection and interaction between the linkage points, a complete knowledge map is drawn to reveal the complex and close linkage relationship between the highly cited literature. It is based on the literature, through the interconnection and interaction between the connecting points, a complete knowledge map is drawn to reveal the complex and close connection between highly cited literature.

3.1. Impact of Artificial Intelligence on Learning

1) Highly Cited Articles by Major Scholars in China

Authors as one of the main body of research, this paper on the impact of artificial intelligence on learning in the field of authors and their co-operation between authors to explore the analysis, using CiteSpace6.2.R4, select Author to visualise the analysis, to get the author map as shown in Figure 1, the number of author nodes N 122, the number of lines E 96, some authors

have lines between nodes, indicating the existence of cooperation, but relatively few lines, most of the nodes do not have lines, as independent.

The number of author nodes N is 122, and the number of links E is 96. Some of the author nodes are connected to each other, which indicates the existence of cooperation, but the number of links is relatively small, and most of the nodes are not connected, which are independent researchers, and the overall situation shows that independent research is the main focus, and cooperation is the secondary focus. According to Price's law, (n_{max} is the number of papers by the author with the most publications) is the core author, and the author with the most publications is Gu Xiaoqing, with 14 publications[5]. The core authors with the largest number of publications are Xiaocheng Gu, Xuesong Qu, Yan Li, Qin He, Xiangjun Hao, Shijin Li, Qin Liu, and Sen Wang.

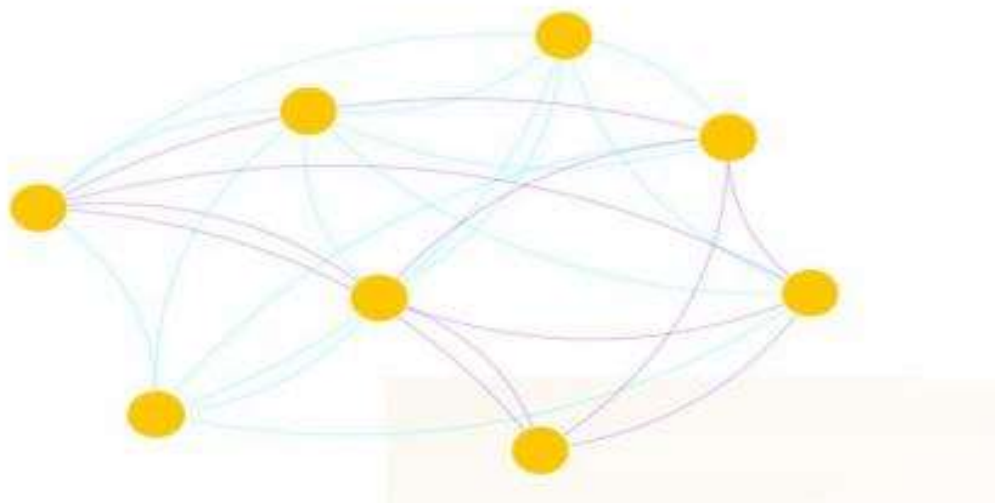


Figure 1. Impact of Artificial Intelligence on Learning Author's Analysis

2) Analysis of co-occurrence of author institutions

The statistical distribution of research institutions can reflect the strength of AI and learning research institutions. There are 13 research institutions with more than 20 articles in AI and learning literature, as shown in Figure 3. From the figure, it can be found that colleges and universities with strong comprehensive strength are the main research institutions for blended learning research and application. Beijing Normal University, East China Normal University, Nanjing Normal University, Jiangnan University and Central China Normal University are the institutions with more publications.

3) Cluster analysis of author institutions

The keywords are clustered into eight categories, and the larger the circle, the more institutions are included in the cluster. The larger the circle, the more institutions are included in the cluster. They are the Department of Education of Beijing Normal University, the Department of Educational Information Technology of East China Normal University, the Department of Education of East China Normal University, the College of Educational Science of Nanjing Normal University, the College of Open Education of East China Normal University, the College of Education of Central China Normal University, the College of Education of Peking University, and the College of Educational Science of Xinjiang Normal University, respectively. The cluster module value (Q value) of the cluster analysis was 0.8589, which was greater than 0.3, and the cluster mean profile value (S value) was 0.983, which was greater than 0.7, indicating that the structure of the clusters was significant and reasonable.

4) Keyword co-occurrence analysis

Keywords can be used to discover the main research content and core ideas in the research field, which can better reflect the research hotspots, research trends and the relevant structure of knowledge. Domestic research on the impact of artificial intelligence on learning The keyword knowledge graph is shown in which the keyword node N is 180 and the connecting line E is 269, and the larger the font size of the node's keyword, the more frequently the keyword appears. In order to achieve a better visual effect, the number of nodes is relatively small, but the number of links between nodes is large, which indicates that the impact of AI on learning has a wide range of research fields and scope, and the research is relatively young. The more connections between the nodes and the denser the connections are, the more in-depth the research on the keyword is and the more closely related the research is [6]. As can be seen in Figure 5, the four keywords with large and obvious nodes are artificial intelligence, deep learning, machine learning, and learning science, indicating that the research on these four keywords is more and more in-depth [9].

As shown in Figure 5, there are 180 nodes and 269 lines in the knowledge graph with the keyword of the impact of AI on learning in China. The keywords with the highest frequency in the co-occurrence analysis are "artificial intelligence", "deep learning", "learning science", "machine learning", of which "artificial intelligence", "deep learning", "machine learning", "machine learning", and "machine learning". The most frequent keywords in the CiteSpace graph are "artificial intelligence", "deep learning", "learning science", and "machine learning", among which "artificial intelligence" appears 260 times in total. each node in the CiteSpace graph is connected to countless branches, and each node is connected to each other. In the field of education technology, there are more and more research directions and keywords for the application of AI in education and teaching, and the cluster analysis of each keyword can present the hot research directions and hot topics in the field in the form of a map. It is more intuitive to see the research focus on the impact of AI in education and teaching.

The impact of artificial intelligence in education and teaching is more intuitive to see the focus of research. As shown in the figure, the larger the keyword, the thicker the line, the stronger the centrality of the keyword, and the more complicated the connecting lines, the higher the degree of association between the keywords.

5) Keyword cluster analysis

The keywords are clustered into 5 categories. The keywords are clustered into five categories, and the smaller the number, the more keywords are included in the clusters. They are artificial intelligence, deep learning, learning science, machine learning, and higher education. The cluster module value (Q-value) of the cluster analysis is 0.5667, which is greater than 0.3, and the average profile value (S-value) of the clusters is 0.7123, which is greater than 0.7, indicating that the cluster structure is significant and reasonable. Cluster #0 Artificial Intelligence, Cluster #1 Deep Learning, Cluster #2 Machine Learning, Cluster #3 Learning Science, Research for "Learning Methods"; Cluster #4 Higher Education.

6) Co-occurrence analysis of keywords and author institutions

The visualised knowledge map created in CiteSpace software with research institutions and keywords as subject terms shows the distribution of research institutions under the key term of the impact of AI on learning. From the figure, we can see that the institutions with larger and deeper research scope are "East China Normal University", "South China Normal University", "Beijing Normal University" and other more authoritative universities in the field of education. It can be seen that the more outstanding and representative institutions in the field of education pay more attention to the development of AI in education and teaching. As shown in the figure, the keywords researched by each university are different, and the research directions they focus on have their own strengths, with the main research directions being "artificial intelligence", "learning science", "machine learning" and "deep learning". " "Deep Learning".

Some university institutions conduct independent research, but most of the universities' research is still related, which shows that AI is still in the stage of continuous exploration in the field of higher education, and there is no complete and systematic research progress, and scholars are still in the stage of continuous change on the impact of AI on learning, lack of systematic analysis, single source of data, lack of innovation, and insufficient depth and maturity of the research. Lack of systematic analysis, single data source, lack of innovation, and insufficient research depth and maturity.

Institutional cooperation is closely related to the number of articles published and the content of research.

In this paper, we drew the knowledge map of issuing institutions through CiteSpace software, and it can be seen from Figure 8 that among the issuing institutions, East China Normal University and South China Normal University are the top cooperating institutions, and the rest of the institutions are the top cooperating institutions[7]. In terms of the number of publications, the top 20 of the 500 selected publications are from major teacher training colleges and universities. East China Normal University (ECNU) published 70 articles, South China Normal University (SCNU) and Shanghai Normal University (SNU) published 50 articles, which is in line with the development trend of domestic scientific and technological research institutes: in terms of highly cited literature, there are more articles and papers published by academic research institutes, and there is a great progress of international cooperation in China. In terms of the number of publications and the distribution of authors in the annual publications, most of the authors of the highly cited literature on the impact of AI on learning in China are located in these universities, forming a knowledge map composed of many scholars in the field of AI-enabled education. However, in terms of the total number of publications, the number of universities in China that conduct research centred on major teacher training colleges is still insufficient, and there is still a big gap between them and the top research institutes such as the Massachusetts Institute of Technology (MIT) in the United States and the University of Oxford in the United Kingdom, and therefore, it is necessary to continue to strengthen the cooperation[8]. Generally speaking, the authors of highly cited literature in China are mainly distributed in domestic teacher training colleges in the field of education, as well as famous foreign academic publishing centres and colleges and universities.

7) Keyword and country co-occurrence analysis

Through the keyword and country search, it is found that among 500 documents, the proportion of Chinese documents is 468, which shows that in the study of the impact of AI on learning, most scholars write in Chinese, and there are fewer in English. The keywords and language knowledge map of domestic research on the impact of AI on learning are shown in Figure 9, in which the keyword node N is 238 and the connecting line E is 568, and the larger the font size of the node keyword, the greater the frequency of the keyword. In order to achieve a better visual effect, the number of nodes presented is relatively small, but the number of links between nodes is large, which indicates that the research field and scope of the impact of AI on learning is extensive and relatively young. The more lines and the denser the nodes are, the more in-depth the research on the keyword is, and the more closely related the research is.

4. Research Insufficiency

This study used CiteSpace for visualisation analysis to obtain visual graphs and knowledge maps through co-occurrence and clustering analysis of keywords and to find out the AI's learning.

Impact. At present, the research of AI on education and teaching is still in the beginning stage, and there are the following deficiencies:

- (i) In the research on AI-enabled education and teaching, researchers' understanding of AI is not comprehensive enough.
- (ii) Scholars' research results on the impact of AI on learning are scattered.
- (c) The researchers' use of educational assessment indicators is still insufficient, which is one of the issues that scholars need to focus on in this area in the future.
- (d) This study only used CiteSpace software as a tool, and only conducted preliminary analyses of the literature in terms of screening, authors, keywords, and institutions. Although the knowledge map produced in this study is based on keywords, a systematic knowledge network map and knowledge map have not been established for the links between keywords.

5. Summary and Outlook

CiteSpace is an analytical tool based on knowledge graph, visualisation and data mining, which can be used for cluster analysis of highly cited literature. In the process of research, this paper reviews the impact of AI on learning. Firstly, we sorted out the domestic research on the topic of AI-enabled education and teaching; secondly, we introduced the relevant visual knowledge mapping analysis tools and visual effect visualisation tools in CiteSpace, and used them to analyse the relevant literature in recent years; and finally, we summarised the current status of the research in this field in China's academia according to the above methods and results [10]. This paper takes the number of articles published in the database of China Academic Journal Network Publishing Database (CNKI) from 2010 to 2023 as the data source, and analyses them by using CiteSpace visualization software, and obtains the following results [11]: According to the research trend and the number of articles published, the impact of AI on learning is becoming more and more in-depth and more and more researches are being conducted. From the perspective of publishing institutions, scholars from domestic universities and research institutions have already conducted relevant research [12]. In terms of the distribution of disciplines, deep learning, machine learning, learning science and other related disciplines that are more frequently used in the field of education are constantly affecting students' learning in this way. By analysing the number of articles and the number of subject terms in the CNKI database, it can be found that the research on AI-enabled education and teaching has been on the rise in recent years; secondly, scholars' research on the impact of AI on learning is fragmented and lacks systematicity [13].

China has always attached great importance to the role of new technologies in promoting the development of education, and more than ten years ago, the National Medium- and Long-Term Reform and Development Plan Outline (2010-2020) already proposed that "information technology has a revolutionary impact on the development of education"[14]. It has been a long time since the introduction of Chat GPT, and it has been a long time since a new technology has been able to cause the education sector to think about and question the current and future teaching methods in a short period of time. In particular, this phenomenon was brought about by a pilot product (a test service that is still being consulted and responded to the market)[1] Chat GPT is just one of the many tools that are built on similar underlying technologies, and this series of tools is changing so fast that we cannot even foresee what they might offer to the public in a year's time. However, it is impossible to ignore the fact that there is a growing consensus in the international community [2] that GPT-4, the upgraded model of Chat GPT, is just the beginning of the development of technologies that will disrupt the traditional education model [3]. From an observer's point of view, the impact of generative human intelligence on the future of education in China is very unclear. There is a need for data and conclusions from testing new technologies in practice, as well as the establishment of research and development programmes to make it easier for teachers and other professionals in the education system to make the right decisions about how to use them. New AI technologies will continue to emerge and will have a

number of changes and impacts on our learning lives, whether positive or negative, but it is important to grasp the advantages and opportunities of AI in learning to promote the development of education and teaching.

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