

Hot Spots, Trends and Implications in Foreign Research on Artificial Intelligence Literacy—Visualization Analysis Based on CiteSpace

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Keywords: Artificial Intelligence Literacy, CiteSpace, Hot Topics, Visual Analytics

Abstract: In this study, 258 articles were selected as a research sample from the Web of Science (WoS) database Core Data Collection from 2014-2023 on the topics of "Artificial Intelligence Literacy," "Intelligence Literacy," and so on. CiteSpace 6.2.4 visualization software was used to conduct bibliometric analysis. The study found that since 2018, the number of foreign articles on artificial intelligence literacy has been steadily increasing; it is mainly in the disciplines of education research, computer science, psychology, robotics and other disciplines, with obvious interdisciplinary characteristics; the phenomenon of authors' collaborative research is more significant; and the hot spots of the research include artificial intelligence, machine learning, and technology.

1. Introduction

With the advent of the AI era, countries are actively promoting AI literacy education, so that the country's citizens have a certain degree of AI literacy to adapt to the current society, in order to enhance the core competitiveness of the country's strategic talents. China released the New Generation Artificial Intelligence Development Plan in 2017, and documents such as the Artificial Intelligence Innovation Action Plan for Higher Education Institutions and the Education Informatization 2.0 Action Plan in 2018, aiming to elevate artificial intelligence to a national strategy^[1].

It can be seen that AI literacy has become one of the basic literacies that people must have in the future society. In the process of carrying out AI education, there is an urgent need to recognize the current research hotspots in the field of AI literacy, the trend of future development, and to clarify the direction of the development of the field. Based on this, this study compiles and analyzes foreign literature in the field of AI literacy, and uses CiteSpace visualization and analysis software to analyze and review the literature, so as to clarify the hotspots and trends of foreign research on AI literacy, and to draw useful conclusions from it, and to provide certain experience for the further development of high-quality AI literacy education in China.

2. Data sources and research methodology

2.1 Data sources

In this study, the core data collection of "Web of Science" database was used as the data source, and "artificial intelligence literacy", "intelligent literacy" and "AI literacy" were used as the subject terms. Intelligent literacy "AI literacy" as the subject term, and the time span is 2014-2023, a total of 298 documents were retrieved. Restricting the research direction to educational technology disciplines such as computer science, educational research, psychology, etc., and eliminating papers and reports that are not related to this paper, a total of 258 documents were obtained as research samples. The document margins must be the following:

2.2 Research methodology

In this study, bibliometrics was used and the research tool was CiteSpace 6.2 software based on Java platform, which mainly used Author, Keywords, Burstness and other functions.

3. Findings and analysis

3.1 Analysis of the number of articles, publications and disciplines

According to the literature analysis of 2014-2017, the number of foreign publications is relatively small, indicating that at this stage, foreign research on artificial intelligence literacy is not a high degree of concern, and the research is in the budding stage. Until 2018 when the number of publications reached 13, the number of foreign AI literacy research literature and the number of citations showed a steady year-by-year increase. 2023 reached the peak of the number of publications and citations in the field of AI literacy research, which may be due to the emergence of a new generation of AI technology such as ChatGPT in 2022, which caused intense discussions among researchers in the field of educational technology disciplines. Artificial intelligence technology has its unique advantages, and the effective integration of artificial intelligence technology and education teaching has become a trend^[2]. AI literacy has become a hot topic as a result.

Table 1: WoS Top 10 Publications of Literature Sources for AI Literacy Research.

Source publications	Number of records	Percentage
LECTURE NOTES IN COMPUTER SCIENCE	17	5.705%
EDUCATION AND INFORMATION TECHNOLOGIES	16	5.369%
LECTURE NOTES IN ARTIFICIAL INTELLIGENCE	8	2.685%
INTERACTIVE LEARNING ENVIRONMENTS	7	2.349%
AAAI CONFERENCE ON ARTIFICIAL INTELLIGENCE	6	2.013%
MOBILE INFORMATION SYSTEMS	6	2.013%
COMPUTERS EDUCATION	5	1.678%
FRONTIERS IN EDUCATION CONFERENCE	5	1.678%
BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY	4	1.342%
COMPUTERS IN HUMAN BEHAVIOR	4	1.342%

The literature on AI literacy retrieved in this study came from 237 publications respectively, and the top ten source publications in terms of the number of articles issued are shown in Table 1. The data in the table shows that the source publications on AI literacy are closely related to the field of

education technology, and all of them have analyzed and studied the application of AI in education from the perspective of combining computers, AI and education. Further analysis reveals that the common focus of the literature is to combine AI with education, classroom, interactive learning, and educational technology for research, which shows that AI literacy is becoming more and more hotly researched in the field of educational technology, and it is a direction that future research should focus on. In terms of the disciplinary distribution of "AI literacy" research results, interdisciplinary research is more obvious, and scholars have explored the topic from 65 research fields, including computer science, education, engineering, psychology, communication, and robotics, and so on.

3.2 Author collaboration analysis

Table 2: Core authors and number of articles published in AI literacy research.

Core authors	Number of articles published
Jiahong Su, Zhijie Wu, Jingxing Chai	6
Qihua Zhu, Guohui Qiu	5



Figure 1: Author Collaboration Mapping for AI Literacy Abroad.

The highly productive core authors of research in the field of AI literacy are listed in Table 2, and it can be seen that Jiahong Su, Zhijie Wu, and Jingxing Chai topped the list of core journal publications with six articles. In terms of the institutions and countries where the high-yield core authors are located, Hong Kong, China has a clear advantage in the number of research outputs. This indicates that scholars in Hong Kong, China, have conducted more extensive research on the topic of AI literacy, which has produced a high academic impact. When we review the major literature related to this area published by the core authors at the top of the table, we can see that the authors in Hong Kong, China mainly focus on the research targets of early childhood, secondary school students, and pre-service teachers^{[3][4][5][6]}. It is worth noting that scholars in Hong Kong, China, have focused their research on how to develop a framework and program implementation for AI literacy development, with research focusing on secondary school students' AI literacy, robotics and engineering teaching, creator education, and teaching strategies^[7]. The author collaboration mapping was performed in CiteSpace 6.2 software, and the results were obtained as shown in Figure 1. It can be seen that there are multiple modes of

cooperation among authors in the field of AI literacy. On the one hand, some authors have close collaboration, for example, Mcnamara, Danielle S (count=4) has close contact with several authors, collaborates more and co-authored several papers; on the other hand, some authors have loose collaboration and establish contact by attending conferences and so on. In summary, most scholars in the field of AI literacy are directly or indirectly connected, forming a learning community with multiple studies.

3.3 Author Keyword co-occurrence and emergence mapping

The keyword visualization co-occurrence mapping shown in Figure 2 and the keyword emergence mapping shown in Figure 3 were plotted in CiteSpace. Figure 2 reflects what are the research hotspots in the field of AI literacy. For example, the hot keywords are "artificial intelligence", "ai literacy", "ai education", "machine learning", "technology", indicating that the research topic of artificial intelligence literacy cannot be separated from the future society of artificial intelligence. Research topics cannot be separated from artificial intelligence technology, education technology, etc. in the future society. Foreign research on patterns, machine learning, technology diagnosis, learning analysis and other technical aspects is more, aiming to give students a certain understanding of artificial intelligence technology; "students ", "children ", "knowledge ", and "impact " are the more current research concerns in the field. In addition to AI literacy, other literacy keywords appear in Figure 3, such as "digital literacy," "literacy," " information literacy ", etc., indicating that scholars' research on AI literacy is not isolated, and that there may be cases where research is conducted in combination with other related literacies, so as to cultivate comprehensive literacy.

As can be seen from Figure 3, among the research emergent words for AI literacy, "acquisition", "evaluation of cal systems", "digital competence", "adult literacy" and so on are highly concerned by foreign scholars, the research frontier related to AI literacy focuses on the enhancement of human-related abilities, and the core of AI literacy is human-centered. In the 2019-2021 timeframe, researchers focus on data literacy, blended learning, artificial intelligence in education, and information literacy, with research frontiers manifesting themselves in a focus on classroom learning and different literacies for basic education students development concerns. Teachers are the main participants and guides in the development of students' artificial intelligence literacy, and teachers' artificial intelligence literacy should be emphasized. An analysis of related literature found that teachers' AI literacy cannot be separated from the cultivation of teachers' literacy such as data literacy and digital literacy, which requires teachers to reserve a certain amount of information technology knowledge to adapt to the current era of information technology and the era of artificial intelligence. The development of teachers' digital literacy should focus on improving teachers' understanding of data and technology knowledge and skills as well as their practical application in teaching^[8]. The development of AI literacy is also closely related to the knowledge, skills, etc. Due to the progress of the times, scholars from 2019 are committed to exploring the basic literacy required by people in the current era, with particular attention to classroom learning and the development of different literacies for basic education students.

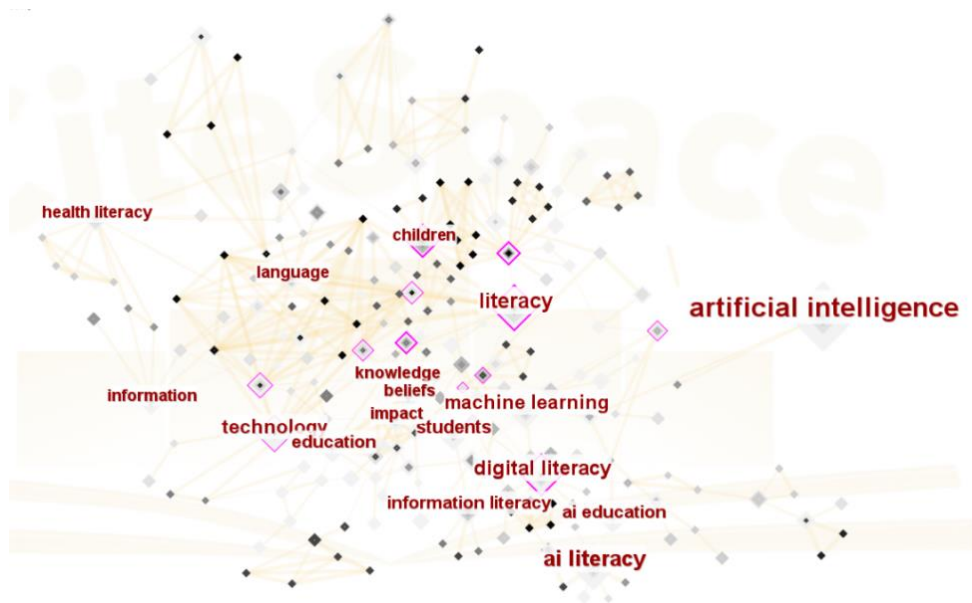


Figure 2: AI Literacy" Keyword Co-occurrence Mapping in Overseas Countries.

Top 25 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2014 - 2023
acquisition	2014	1.51	2014	2015	
evaluation of cal systems	2014	1.09	2014	2017	
digital competence	2014	1	2014	2018	
adult literacy	2016	1.25	2016	2017	
classroom	2016	1.12	2016	2017	
ability	2017	1.09	2017	2019	
2nd language	2017	1.09	2017	2019	
language	2014	1.68	2018	2019	
behavior	2018	1.17	2018	2019	
achievement	2018	1	2018	2020	
beliefs	2016	0.98	2018	2019	
children	2014	2.13	2019	2020	
instruction	2019	2.1	2019	2020	
data literacy	2019	1.58	2019	2020	
blended learning	2020	1.84	2020	2021	
information literacy	2016	1.34	2020	2021	
machine learning	2020	1.32	2020	2021	
adoption	2020	1.14	2020	2021	
science	2020	1.13	2020	2021	
artificial intelligence in education	2020	0.92	2020	2021	
behavioral intention	2020	0.92	2020	2021	
3-early adolescence	2020	0.92	2020	2021	
higher education	2021	2.03	2021	2023	
financial literacy	2021	1.62	2021	2023	
ai and ethics	2021	0.81	2021	2023	

Figure 3: Top 10 foreign "artificial intelligence literacy" buzzwords.

4. Insights on the hotspots of AI literacy research abroad

4.1 Pointing from single literacy to the cultivation of co-occurrence comprehensive literacy

According to the drawn keyword co-occurrence mapping, it can be learned that the trend in the field of foreign research on AI literacy is to focus on the AI literacy needed in the current era on the basis of the research on information literacy, digital literacy, data literacy, etc., and the integrative and correlative features are particularly prominent in the current foreign research. It is worth

mentioning that there have been studies combining digital literacy on AI education to investigate the impact of teachers' digital literacy on early childhood AI education ^[9]. From the perspective of disciplinary integration, the future integration of knowledge from different disciplines further promotes the development of AI education, for example, cultivating students' AI literacy in science, technology, mathematics and other disciplines ^[10], so as to cultivate the public's comprehensive literacy in the age of AI.

4.2 Emphasizing Research in the Field of Artificial Intelligence Literacy Education

An analysis of the literature reveals that scholars have long been concerned about and conducted research on AI literacy, however, research on AI literacy in education has only begun to show a boom since 2018 ^[11]. Foreign scholars have conducted a lot of research on the theoretical definition and practical application of AI literacy in education. In terms of theoretical definition, some scholars have explored the components of AI literacy and developed assessment scales ^{[12][13]}, and the research object focuses on primary and secondary school students and teachers. From the perspective of high-quality development of education, future research in the field of AI literacy should expand the scope of research objects, such as teacher trainees and other special groups. In addition, AI literacy has been divided into different dimensions, mainly including knowledge, skills, and ethical requirements. However, researchers of AI literacy need to pay further attention to the improvement of students' attitudes and awareness of AI technology.

4.3 Deepening the Research Level of Artificial Intelligence Literacy

Artificial intelligence literacy, as a branch of the field of artificial intelligence, related research should be deepened with the innovative application of artificial intelligence technology. The field of artificial intelligence involves a number of subject areas, and the research of artificial intelligence also needs to deepen the recognition of emotions and sentiments, and integrate with brain science, cognitive psychology and other disciplines ^[14]. By analyzing the co-occurrence and emergence of keywords, this study found that very few of the high-frequency keywords in the field of AI literacy are linked to emotion and cognition. Therefore, future research can expand the breadth and depth of the study to explore the influencing factors of the cognitive aspect of AI literacy and construct a framework of AI literacy that is more suitable for different learners.

5. Conclusions

In recent years, the development of artificial intelligence technology has advanced by leaps and bounds, and it also marks our entry from the information age into the age of artificial intelligence^[15]. Artificial intelligence literacy is a national demand for cultivating strategic talents, and it is also a basic literacy necessary for the age of artificial intelligence. To this end, we firstly analyzed the number of articles, citation trends, publications and discipline distribution in the field of AI literacy in the past decade; secondly, we screened and collected the literature on the theme of "AI literacy" in the WoS core database, and used the bibliometric analysis software, CiteSpace, to carry out a visual analysis, and came up with the results of the current research in the field of AI literacy. Secondly, we screened and collected the literature on the topic of "artificial intelligence literacy" from the WoS core database, and visualized and analyzed it with the literature metrics analysis software CiteSpace, so as to find out the current research hotspots and development trends in the field of artificial intelligence literacy.

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