Research Status and Prospect of Artificial Intelligence Education in Primary and Secondary School

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Abstract. Strengthening the education of artificial intelligence in primary and secondary schools aims at popularizing artificial intelligence and training the citizens to have the intelligence literacy that matches the intelligence era. By distinguishing concepts and connotations related to maker education, STEM education, and artificial intelligence education, at the same time, CiteSpace tool is used to analyze the AI education in primary and secondary schools from the author's volume of papers, writing institutions, keywords, pop-up words and so on, to clarify the current research status and development trend of artificial intelligence education in primary and secondary schools. The result shows that artificial intelligence, intelligence education, robot and programming education are the key points and hotspots of artificial intelligence education in primary and secondary school.

Keywords: Intelligent literacy · Artificial intelligence education · Primary and secondary school · CiteSpace

1 Introduction

In recent years, with the rapid development of the Internet of Things, the Internet, blockchain, 5G and other technologies, it is an inevitable trend for human beings to enter the era of intelligence from the era of information. As a national and party plan, education is also facing the reform of intelligence. The development, trend and hotspot of AI education has become an important research direction of the current topic. AI has brought new business development to the education industry, as well as new challenges and opportunities to the education system. With the introduction of relevant policy documents and the deployment of development strategies, the research and implementation of AI education in primary and secondary schools are in a state of intense development. Therefore, it is necessary to sort out the development of AI education in primary and secondary schools in order to provide reference for the development, implementation and implementation of AI education in primary and secondary schools.

2   Concept and Connotation

The development of science and technology is springing up like bamboo shoots after a spring rain, and the corresponding proper nouns are emerging, which inevitably leads to the phenomenon of misrepresentation. In order to better distinguish the various professional terms, the concepts and development connotations of maker education, STEM education and artificial intelligence education are distinguished.

2.1   Maker Education

The concept of maker education comes from the United States, which originated from the Maker Education Initiative (MEI) launched by the White House, led by Dale Dougherty, the leader of the maker movement. The Maker Education Program aims to stimulate children's interest, confidence and creativity by strengthening the construction of maker space and developing various maker projects, so that every child can become a maker. Fu Qian et al. [1] believe that Creator Education is to introduce the existing concept of Creator into primary and secondary education, and to implement some comprehensive courses on innovative hands-on skills training in order to solve the problem of insufficient training of students' innovative hands-on ability. Yang Xianmin et al. [2] put forward that Creator Education upholds the educational concept of "open innovation, inquiry and experience", takes "learning in creation" as the main learning mode, integrates information technology, and aims at cultivating all kinds of innovative talents.

Generally speaking, Creator Education is a way to cultivate children's innovative thinking and ability, advocate innovation and sharing, and improve their ability to solve problems across disciplines.

2.2   STEM Education

STEM is an acronym for Science, Technology, Engineering and Mathematics. As early as 1986, the National Science Council of the United States published "Undergraduate Science, Mathematics and Engineering Education", which first put forward the programmatic proposal of "Integration of Science, Mathematics, Engineering and Technology Education", which is regarded as a milestone in STEM education in the United States, and is also the origin of STEM concept. Fu Qian et al. [3] said that STEM education mainly cultivates students' comprehensive ability to apply STEM knowledge to solve problems through several learning methods, such as application inquiry, project-based and design-based learning, which is a teaching strategy. In short, STEM education is an educational model based on interdisciplinary and project-based learning with science, technology, engineering and mathematics as its core.

2.3   Artificial Intelligence Education

As for the concept and definition of artificial intelligence, the academic circles have given various statements from different perspectives. In Artificial Intelligence and Education: a Guide for Policy Makers, it is pointed out that artificial intelligence is a computer system designed to interact with the world with the existing human capabilities. Machine

learning, deep learning and neural network belong to the underlying technologies of artificial intelligence, which together give birth to a series of applications based on artificial intelligence technology, including speech, image recognition and emotion detection, and are widely used in various fields of economy and society.

The development of artificial intelligence provides new ideas and methods for the reform of education system. The formulation of artificial intelligence education originated from China, which also indicates the progress and improvement of China's comprehensive strength. With regard to artificial intelligence education, Jiang Shuhui et al.[4]believe that artificial intelligence technology, including machine learning, self-speaking language processing, human-computer interaction, computer vision technology, etc., has been proved to be able to effectively explain the educational theory of education itself after years of practice, or to conform to the educational practice of the inherent development law of teachers and students, thus forming a situation of integration of teaching and technology.

3 The Development Status of Artificial Intelligence Education

The development of artificial intelligence is in the stage of blooming flowers, and the education of artificial intelligence has attracted wide attention from all walks of life. This study used the CiteSpace tool to search the CNKI library. Searching on the subject of artificial intelligence education in primary and secondary schools, 317 papers were obtained, and 306 papers were finally obtained after sifting out the papers irrelevant to the subject.

### 3.1 Number of Papers Issued by Domestic and Foreign Authors

According to Price's law, the formula for the number of papers issued by core authors is $M \approx 0.749\sqrt{n_{max}}$. Where, M is the minimum number of posts issued by core authors, n_ Max is the maximum number of documents. It can be seen from Table 1 that in the ranking of the number of papers published in the literature related to AI education, the scholars with the highest number of papers are Li Shijin and Gu Xiaoqing, with 4 papers published respectively, followed by Zhao Leilei and Zhao Keyun. From this, $M \approx 1.50$ is calculated. According to the upward rounding principle, the core authors in this field are those with 2 or more articles published by domestic authors, with a total of 26 people. The data shows that domestic scholars' research on AI education is still in the exploratory stage, and the core leaders represented by some scholars have not yet formed.

3.2 Issuing Agency

As shown in Fig. 1, the top ten institutions in the number of documents issued are colleges and universities, and they are normal colleges and universities, indicating that China's normal colleges and universities are the main front of AI education research. Among them, the top three are Beijing Normal University, East China Normal University and South China Normal University. Through the analysis of the institutional map

Table 1. Number of papers published by authors on AI education

Serial number	author	Number of documents issued
1	Shijin Li	4
2	Xiaoqing Gu	4
3	Leilei Zhao	3
4	Keyun Zhao	3
5	Xinmin Sang	3
6	Jianping Zhang	2
7	Lingyan Ji	2
8	Xiaomin Du	2
9	Ye Mo	2
10	Jinbao Zhang	2
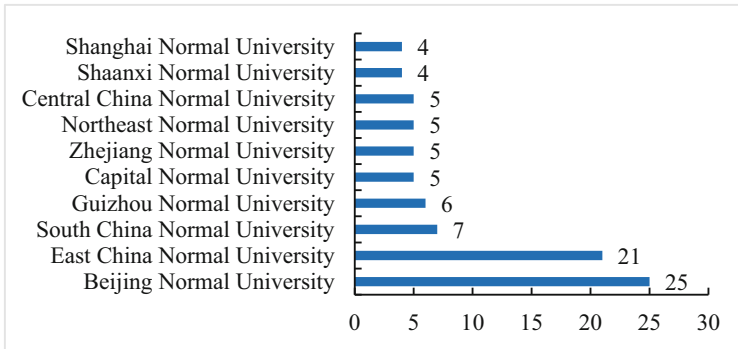
Fig. 1. Top 10 institutions with the number of Chinese documents

co-occurrence, it is found that in addition to the links between colleges and universities, the links between colleges and universities are not close, and there is basically no cooperation, which indicates that China's universities and institutions are not close, and the strengthening of exchanges and cooperation between universities and institutions is the direction that we need to pay attention to and pay attention to in the future.

3.3 Keyword Analysis

The key words are the core summary of the article and the key points of the article. To some extent, they can reflect the research focus of AI education. According to the analysis of the literature keyword co-occurrence map(the keyword co-occurrence map is shown in Fig. 2), there are 229 keywords in total, of which the top ten keywords are listed in Table 2. The frequency and centrality of AI, primary and secondary schools, intelligent education and robots are the highest, which is the focus of AI education research in primary and secondary schools.
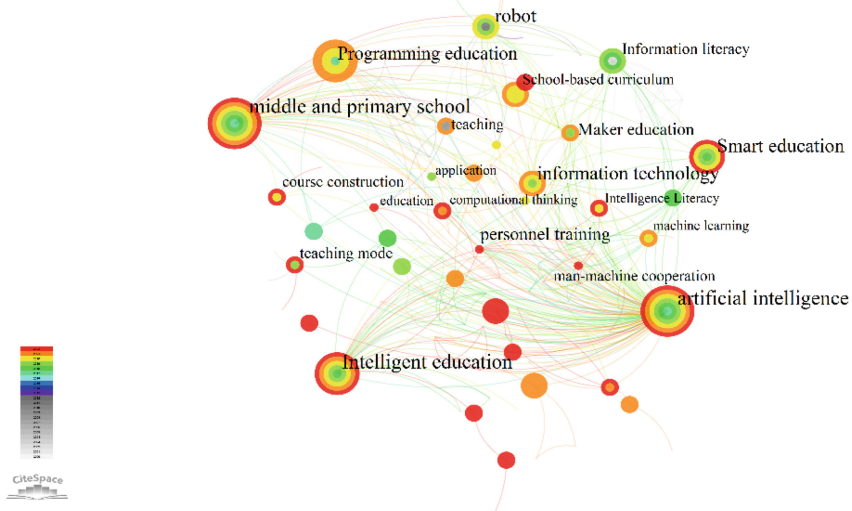
Fig. 2. Keyword co-occurrence map

Table 2. Top 10 keywords in total frequency

Serial number	Key word	Centrality	frequency
1	artificial intelligence	1.1	145
2	middle and primary school	0.23	47
3	Intelligent education	0.13	26
4	robot	0.12	13
5	Smart education	0.02	10
6	information technology	0.04	10
7	Programming education	0.02	10
8	Maker education	0.05	9
9	personnel training	0.02	9
10	Information literacy	0.1	7

3.4 Emergent Word

Emergent words refer to keywords that appear more frequently in a short period of time or are used more frequently by scholars. Emergent words can reflect the forefront of research in the field of AI education to a certain extent. The top 4 highlighted words are shown in Fig. 3. High school curriculum, information technology, education, robotics,

Keywords	Year	Strength	Begin	End	2003 – 2022
robot	2006	3.46	2006	2017	
teaching	2006	2.43	2006	2011	
Programming education	2017	1.66	2020	2022	
School-based Curriculum	2020	1.52	2020	2022	

Fig. 3. Keywords with the strongest citation bursts

teaching, normal school students, intelligent education, application, information literacy, countermeasures and suggestions, big data, content design, programming education, school-based curriculum and machine learning are the key points of artificial intelligence education research in primary and secondary schools. Among them, "robot" appeared in 2006, such as a sudden rise, with a Burst value of 3.46. Then, in 2020, there were programming education, school-based courses and machine learning, reflecting the current surge in research focus of scholars in artificial intelligence education in primary and secondary schools, which is of turning significance.

Scholars also put forward their own ideas and views on AI education. Chen Xiangmei et al. [5] put forward AI education anxiety, believing that AI education anxiety is a kind of anxiety in the application of AI technology in the field of education, and elaborated on data security, misleading dependence, prejudice and discrimination, and AI learning anxiety. Shen Lingling et al. [6] realized the "doable" and "undoable" of AI through Moravec paradox, and further discussed the "why" and "what" of AI in the field of education, and explained the hidden worries and coping strategies of the development of AI education. Liang Yunzhen et al. [7] put forward the practice strategy of "AI + X" interdisciplinary integration teaching from five aspects: target positioning, content design, activity organization, resource creation and evaluation methods, in order to promote the innovation and development of AI education through inter-disciplinary integration.

With the advent of the era of intelligence, the state attaches great importance to artificial intelligence education, and the research on artificial intelligence education in primary and secondary schools has entered an upsurge. To make artificial intelligence education sustainable development, we still have a long way to go and need strong support from all sectors of society.

4   Conclusion

4.1   Build an Intelligent Educational Environment and Build a Multi-modal Educational Resource Service System

Infrastructure construction supported by emerging industrial technologies such as the Internet of Things, block chains, the Internet, big data and artificial intelligence provides a basic guarantee for the digital transformation of the national economic system. The construction of new educational infrastructure also emphasizes the construction of information networks and platform systems. It is necessary to strengthen the development of artificial intelligence education, build an intelligent educational environment, and provide guarantee and support for artificial intelligence education. Students can experience

artificial intelligence through the experience and use of the relevant environment, so as to deepen their understanding and mastery of artificial intelligence.

4.2 Improve the Artificial Intelligence Training Mechanism for Primary and Secondary School Teachers and Strengthen the Teaching Staff

Teachers are the practitioners of educational reform, and teachers play an important role in promoting the development of artificial intelligence. Artificial intelligence, as a new technological means, requires teachers to learn, receive and digest it, and then teach it to students in an appropriate way and means. To a large extent, artificial intelligence can help teachers complete the teaching content and reduce the burden of teachers. However, teachers need to continue to learn and deepen how to popularize artificial intelligence to students, and target students of different grades and stages, so as to achieve the popularization of artificial intelligence, and then cultivate students' intelligent literacy. Therefore, it is very necessary to establish and improve the artificial intelligence training mechanism for primary and secondary school teachers.

4.3 Strengthen the Cooperation Between Universities and Primary and Secondary Schools, and Build a Diversified Talent Training Position

We should strengthen the cooperation between universities and primary and secondary schools in the field of artificial education, establish a long-term mechanism of two-way communication, build a cooperative community of university teachers and secondary school teachers, further improve the quality of personnel training, and promote the mutual development of teachers. Through cooperation and exchanges between universities and primary and secondary schools, we can also bridge the gap between educational theory and practice, promote the mutual promotion of theory and practice, give full play to the linkage between university teachers and middle school teachers, build an all-staff education mechanism, a diversified talent training position, a complete education chain, form a joint force of education, and jointly improve the quality of personnel training.

4.4 Implementing the Trinity of "Government-Enterprise-School" to Promote the Landing of Artificial Intelligence Education

The "government" of "government-enterprise-school" is the government, the "enterprise" is the enterprise, and the "school" is the "school". Although the government does not participate in the direct operation of school-enterprise cooperation, the improvement and formulation of relevant policies and systems by the government have a great impact on school-enterprise cooperation. The government dominates the direction of education development and provides a direction for education. In addition, the government also builds a plaorm for cooperation between enterprises and schools through policy formulation, resource integration, planning and development. Participating in school-enterprise cooperation is not only conducive to the development of enterprises themselves, but also the embodiment of their social responsibility. Enterprises mainly provide R & D plaorms for the development of school education, including the development and manufacture of teaching equipment, facilities and teaching software and hardware. As the main position of education, schools have an unshirkable responsibility for personnel trainings.

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