Current Status, Hotspots and Future Prospects of Intelligent Education Research in China

-- CiteSpace based visual analysis

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Abstract. With the application of a new generation of intelligent technologies in education, represented by cloud computing, big data, Internet of Things, artificial intelligence and blockchain, China's education is increasingly moving into the era of intelligence. The article takes some academic papers related to the topic of "intelligent education" collected in CNKI database from 2017 to 2022 as the research object, and uses CiteSpace software to profile and analyze the current situation of domestic intelligent education research and research hotspots. The study found that the overall number of articles published showed a trend of "intelligent education". The study found that the number of articles published showed an overall increasing trend, and the research hotspots mainly focused on smart education technology and application, smart education ethics, and human-computer collaboration in the age of intelligence. Deep learning, smart education, learning analytics, knowledge mapping and education ethics are the future research trends.

Keywords: Intelligent Education; Current State Of Research; Research Hotpots; Citespace; Visual Analysis.

1. Introduction

The new round of technological revolution represented by artificial intelligence is profoundly changing human society. The deep integration of artificial intelligence and education has become an inevitable trend for future education. The social changes triggered by this new technological revolution are also continuously reshaping the existing education forms and contents, and education is increasingly moving towards an era of intelligence.[1] The strategic objectives of China's AI development and the development direction of intelligent education are clearly defined in the 2017 Development Plan for a New Generation of Artificial Intelligence, which emphasises the use of intelligent technology to promote education transformation and change .[2] In April 2018, the Ministry of Education released the Education Informatization 2.0 Action Plan", the document clearly proposes to use the emerging technologies of AI as the basis to promote the model change and ecological reconstruction of education under new technology support, and vigorously promote the application of AI in the whole process of teaching. The importance the country attaches to the application of AI in education speaks for itself. AI plays a key role in promoting the development of education informatization, and smart education is an inevitable choice to comply with the development of education in an intelligent environment and an effective way to accelerate the modernization of education.[3] The Ministry of Education's 2022 Work Highlights clearly proposes to accelerate the digital transformation and intelligent upgrading of education, and to promote the pilot work of artificial intelligence to help build the teaching force. The 14th Five-Year National Informatization Plan points out that informatization has entered a new stage of accelerating digital development and building a digital China, and deploys ten major tasks such as building a ubiquitous and intelligent digital infrastructure system and constructing an industrial digital transformation development system. A literature search revealed that domestic research on intelligent education began at the beginning of this century.

In 2000, scholars introduced the term "smart education", which is a kind of distance education and a means to achieve large-scale personalised education .[4] In 2018, scholars pointed out that smart education consists of three aspects, education supported by smart technology, education to learn smart technology and education to promote smart development .[5] In recent years, the research on smart

education in China has also gradually increased. In order to further clarify the research status, research hotspots and possible future directions of smart education in China, this paper uses Citespace software to visualize some 251 academic papers from CNKI 2017-2022 related to the topic of "smart education" in the form of knowledge graphs. This paper uses Citespace software to visualize and analyze some 251 academic papers from CNKI from 2017-2022 on the topic of "intelligent education" in the form of knowledge graphs to show the research situation of intelligent education in China, and provide reference and reference for researchers to understand the current situation and development trend of intelligent education research in China.

2. Research Methodology and Data Sources

2.1 Research Methodology

This paper uses citespace software to analyse the literature on the topic of 'smart education'. Elements of the analysis include author, institution, keywords and time, in order to analyse and summarise the hot topics and cutting-edge research in the field.

CiteSpace software is a visual representation of the structure, patterns and distribution of scientific knowledge. [6] The results of this analysis are known as 'scientific knowledge mapping'. The direct object of scientific knowledge mapping is scientific knowledge, based on scientometrics as a theoretical foundation and covering the intersection of science, applied mathematics, information science and informatics.[7] Compared to traditional literature reviews, scientific knowledge mapping provides researchers with a clearer visualisation of the knowledge and research hotspots in their field of study, making it easier to understand the knowledge in the field and to have a better grasp of the future direction of the field.

2.2 Data sources

In order to ensure the comprehensiveness and authority of the literature in the CNKI Chinese database, this study used the topics of "intelligent education", "artificial intelligence education" and "artificial intelligence in education". The search was conducted with the search terms "intelligent education", "artificial intelligence education" and "educational artificial intelligence", and the search time range was set from 2017 to 2022. file includes author, institution, title, abstract, keywords, journal and other information. After the exclusion of unqualified literature and the exclusion of papers that did not meet the requirements, the total number of relevant documents needed for this study was 251, i.e. a total of 251 records were finally analysed using CiteSpace software.

2.3 Data processing

This study uses CiteSpace software to analyse trends in the number of articles published, their authors and institutions, in order to obtain the current status of their research. The number or frequency of recurrence of keywords in the field of "intelligent education" was also detected in Citespace, and co-occurrence analysis was conducted to understand the research hotspots and trends in the field. In terms of setting the threshold parameters, the Time Slicing was set from 2017 to 2022, the Node Types were set to Keyword, author, institution, etc., and the pruning strategy was chosen from Pathfinder, Pruning Sliced Networks.

3. Current status of research

3.1 Analysis of the number of articles issued

By analysing the number of articles published in a certain research area, it is possible to clearly derive the development trend and the level of research fervour of that research in each time period. This study analysed the number of articles published in CNKI in the core and CSSCI journals of Peking University for the five years from 2017-2022, and the analysis found that the number of

articles published generally showed a wave-shaped upward trend. Figure 1 shows that the number of articles published in intelligent education in China is on an upward trend.

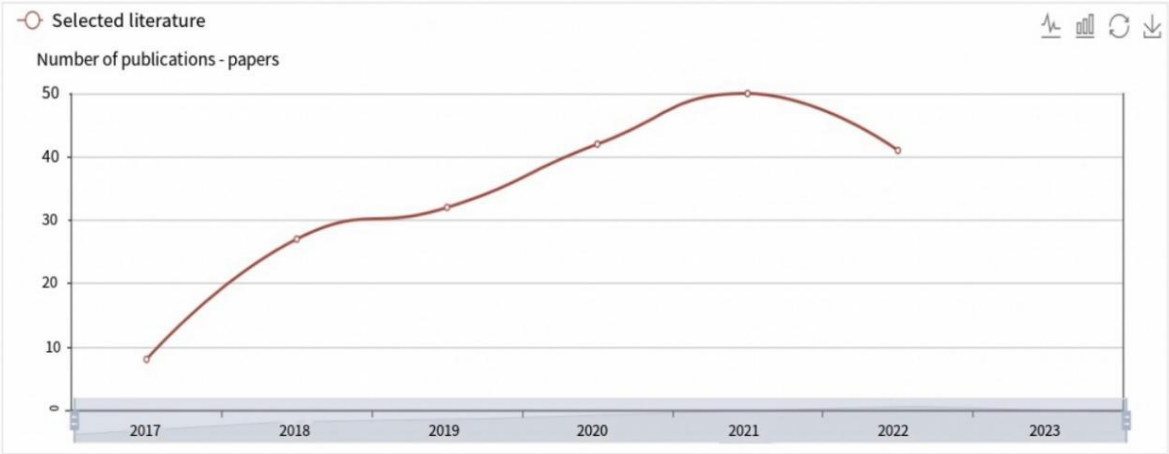


Fig. 1 Annual distribution of the number of articles published in the smart education research literature: 2017-2022

It is clear from the graph that in 2017 there was still less literature on smart education, but from 2017 to 2018 there was a significant increase in the number of articles published, with the annual increase from 2017 to 2018 reaching 20 articles, indicating that smart education became a research point for many scholars from 2018 onwards. After 2018, the number of publications continued to rise, with 2021 being the highest year of publication in the selected literature, and although there was a decrease in 2022, the overall number of publications was still high. This phenomenon is also related to the national policy. 2017 "two sessions" for the first time included artificial intelligence in the government work report, "a new generation of artificial intelligence development plan" will develop artificial intelligence as a national strategy .[8] On April 2, 2018, the Ministry of Education released the "Action Plan for Artificial Intelligence Innovation in Higher Education" to further improve the innovation capacity of universities in the field of AI.[9] In 2019, the "China Education Modernization 2035" proposed to vigorously promote education informatization.[10] The call of the state and the call of the times have all led to an increase in research in this field, which has gradually become a major research hotspot in recent years.

3.2 Analysis of authors and number of articles published

In the Citespace software, the node type is "Author", and the authors of the selected papers are analysed, so that it is possible to visualise which scholars are influential in the research field and to obtain a co-occurrence network map of authors, as shown in Figure 2.

Figure 2 shows that Gu Xiaoqing, Li Shijin and Wu Yonghe from East China Normal University, Liu Bangqi from Northwest Normal University, Zheng Yongyan and Wang Yiyan from Beijing Normal University, and Huang Ronghuai from Beijing Normal University have more publications and influence, indicating that they are the main researchers in the field of intelligent education in that time period. The cooperation and connection between the nodes is indicated by linkages, for example, with the Liu Bangqi node as the core, interlinked authors such as Wu Yonghe, Wang Yafei, Zhu Guangjian and Xu Jiahui, who are scholars from Anhui Ke Da Xunfei Information Technology Co Ltd and East China Normal University, together forming a collaborative group. This is in addition to a core group of collaborators including Huang Ronghuai from Beihang Normal University and Lan Guoshuai from Northeast Normal University. Although the collaboration within the team has significant results, the degree of interconnection between the team and the team is small, and there is a lack of cooperation and communication.



Fig. 2 Mapping of author collaboration co-presence networks

In the statistics of the number of articles published by authors, the majority of authors have only published one paper, which indicates that China's research in the field of intelligent education has not yet formed a very core research group, indicating that intelligent education still needs to be studied by scholars at a deeper level.

Table 1. Statistics on the number of articles published by authors

Author Posts	Number of people
9	1
7	2
5	2
4	2
3	4
2	29
1	132

3.3 Analysis of issuing institutions

Citespace was used to analyse the institutions to obtain a network of institutions, based on which the distribution and collaboration of the research content in different research institutions was obtained. By changing the node type in Citespace to "Institution", we find that China has initially formed a research base of intelligent education mainly in higher teacher training institutions, the Department of Educational Information Technology of the Faculty of Education of East China Normal University, the School of Educational Information Technology of South China Normal University, the Faculty of Education of Beijing Normal University, the School of Information Technology and Technology of Northeast Normal University, and the School of Educational Science of Nanjing Normal University, which have issued more articles, and these institutions all belong to more developed regions in China, indicating that the development of a certain research field has a great relationship with the local economic development and policy support, and it can also be assumed that these schools have more in-depth research on intelligent education and have contributed to the research on intelligent education. However, through the density of connectivity, there is less collaboration between major research institutions, indicating that China's smart education research still needs increasing collaboration among major research institutions to establish a more systematic and core network of collaboration.

4. Research hotspots and evolutionary analysis

4.1 High frequency keyword analysis

The keywords in a thesis are of practical importance to the central content of the thesis. In much of the literature, an analysis of the keywords gives an indication of the frequency of occurrence of keywords in a given field over a specific time interval, and a ranking of the keywords by frequency gives a visual indication of the research dynamics and research hotspots in the field. [11] The keywords in a paper can reflect the core of research and the main research directions in a given research area. [12] In this paper, keyword analysis is carried out using Citespace software, which provides a good overview of the links and developments in the research topic and allows a clear view of the hotspots in the research area. In this paper, the keywords are used as nodes and the analysis time slice is 1 year, thus generating a keyword co-occurrence map, as shown in Figure 3. At the same time, on the basis of Citespace software for the selected literature among the keywords appear more times in the categories of the summary, in order to explore the current intelligent education research hotspots, China's intelligent education high-frequency keywords as shown in Table 2.

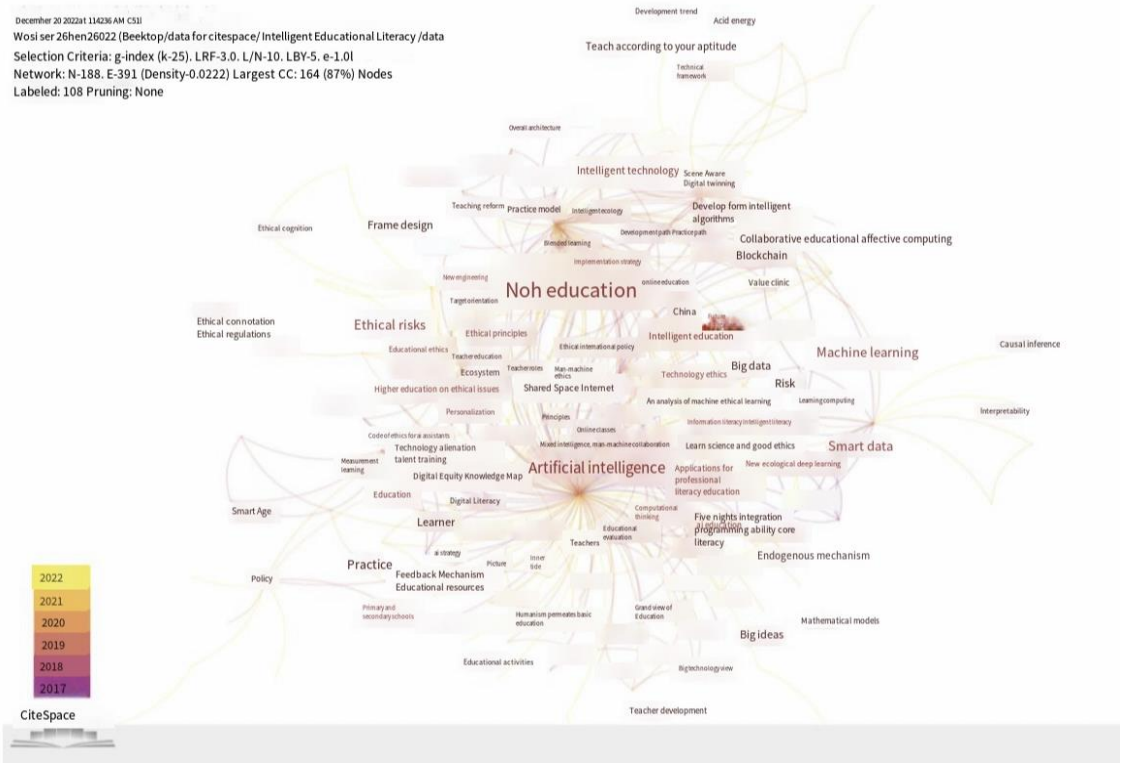


Fig. 3 Keyword co-occurrence mapping

The graph shows that the keyword network density is 0.0222, and the structure of the keyword co-occurrence network is tight and loose. This suggests that in the future research institutions will need to work closely together and the research content will need to be more in-depth and focused. The graph shows that artificial intelligence and smart education are the most frequent keywords in the 251 selected documents; smart technology, smart education, machine learning and educational applications also appear more frequently. With the advancement of science and technology, the development of artificial intelligence has become faster and faster, and the application of artificial intelligence technology to education and the development of intelligent education is conducive to improving teaching efficiency. Intelligent education is now a new paradigm in education. The use of AI in education allows teachers to improve their teaching, better impart knowledge to students, enable students to learn better, stimulate their enthusiasm for learning, and make them more interested in learning, thus improving their grades and abilities in all areas.

In the CiteSpace software, the key node is the intermediary centrality over 0.1. The intermediary centrality depicts the degree of importance of the intermediary node in the node network, the higher the centrality value, the more nodes are connected through the node, indicating that the node is more important in the node network structure [13]. According to the keyword frequency table, the high frequency keywords are, in descending order, artificial intelligence (130), smart education (39), human-machine collaboration (13), educational applications (13), smart technology (13), smart education (10), big data (9), machine learning (9), talent development (7) and deep learning (5). Apart from the basic search term "smart education", the other nine can be considered to be the current research hotspots for smart education.

Table 2. Summary of keyword frequency and centrality

No.	Keywords	Frequency	Centrality
1	Artificial Intelligence	130	0.62
2	Smart Education	39	0.62
3	Human-machine collaboration	13	0.12
4	Educational applications	13	0.22
5	Smart Technology	13	0.13
6	Smart Education	10	0.01
7	Big Data	9	0.14
8	Machine Learning	9	0.08
9	Talent Development	7	0.03
10	Deep Learning	5	0.05

4.2 Analysis of research hotspots based on keyword clustering

Keyword clustering analysis is the process of reducing co-occurrence network relationships to a relatively small number of clusters based on co-occurrence analysis.[14] CiteSpace's keyword clustering function can identify hot spots and trends in a number of research areas.[15] Keyword clustering through CiteSpace is used to further identify research themes in the field of intelligent education research in China. CiteSpace software was used to cluster and analyse the keywords in the literature data to obtain a keyword clustering map as shown in Figure 4.

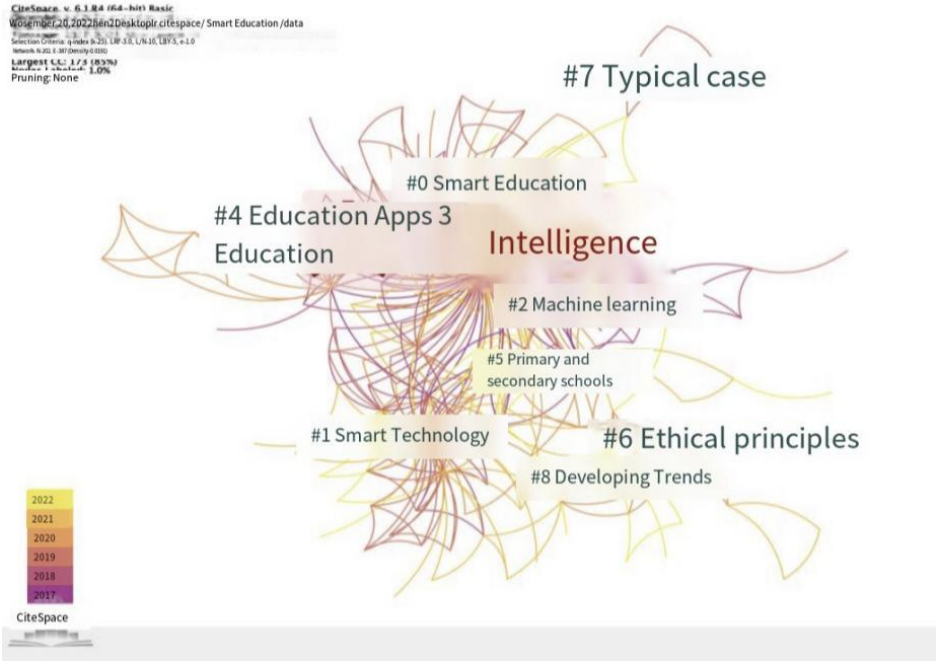


Fig. 4 Keyword co-occurrence clustering mapping

From Figure 4 it can be found that the keywords present nine clusters: intelligent technology, machine learning, education, educational applications, primary and secondary schools, ethical

principles, typical cases, and development trends. It can likewise be argued that the above clusters are also hotspots for research on smart education in China.

4.3 Analysis of research frontiers based on keyword emergence

A research frontier is "a dynamic set of concepts and potential research questions that emerge", and emergent words are those that are frequently cited or appear with high frequency in the relevant literature.[16] At a given time, emergent words can be used as one of the criteria for determining and predicting research frontiers[17] .

The study used CiteSpace to analyze and explore the emergent words in the sample data of relevant literature in the field of smart education research, and obtained 10 emergent words (shown in Figure 5), namely "deep learning", "smart education" "learning analytics", "knowledge graph", "education ethics", "future education" The 10 emergent terms were "smart divide", "digital intelligence integration", "emotional computing" and "smart era".

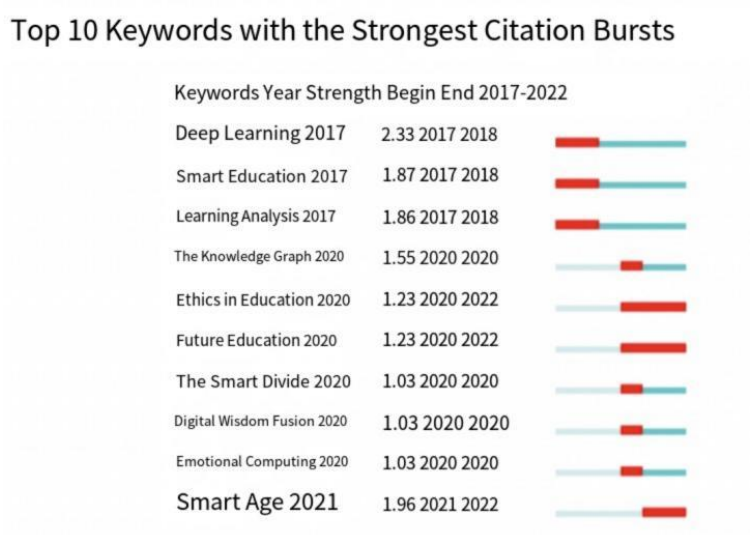


Fig. 5 Mapping of emergent words

In the research sample data, research on "deep learning", "smart education" and "learning analytics" is gradually developing from 2017 onwards; from 2020 onwards "Knowledge mapping", "education ethics", "future education", "the smart divide" From 2020 onwards, research on "knowledge mapping", "education ethics", "future education", "smart divide", "digital intelligence integration" and "affective computing" will gradually develop and increase; from 2021 onwards, research on "smart age" will also become popular. From the intensity of the keyword emergence, it can be seen that "deep learning" is the most emergent keyword, followed by "smart era", "smart education" and "learning analytics". learning analytics" and so on. It can be assumed that in the next few years, China will continue to conduct research in these areas of intelligent education.

4.4 Analysis of research frontiers based on keyword time zone maps

In order to understand the use of different keywords over time, this study has tabulated a timeline mapping of cutting-edge keywords for smart education in China by time slice. The keywords are divided into themes representing research hotspots and marked on the timeline, highlighting the hotspot evolution trend in the field of smart education in China in the past six years. As can be seen from the figure, the integration of artificial intelligence and education teaching has been a trend from 2017 to the present, with smart education, artificial intelligence and smart education all being research hotspots. between 2017 and 2021, human-computer collaboration, smart technology, educational ethics, knowledge mapping and so on are all research hotspots during this period. In 2022, the key words are core literacy, ethics of responsibility, and scenario construction. This indicates that smart education is gradually focusing on the cultivation of students' core literacy, the importance of humanistic ethics of responsibility, and the construction of learning scenarios. It can be found that

intelligent education attaches importance to the use of technology without detaching from the humanities, and that it focuses on technology as well as the cultivation of students' literacy, the development of their abilities and personalisation, and also on educational ethics. It is believed that in future research on intelligent education in China, scholars will also study the use of technology, learner development and humanistic development of education in intelligent education.

5. Conclusions and outlook

5.1 Research findings

By using Citespace, this article analyzes the literature of Peking University core journals and CSSCI journals in China Knowledge Network for the purpose of researching the current situation and hotspots of intelligent education research and research trends in China. The article provides a systematic visual analysis of smart education research within 2017 to 2022 to draw several conclusions as follows:

1). From the distribution of keyword co-occurrence network and the results of analysis with time zones, it can be seen from the analysis of 251 documents that smart education mainly focuses on artificial intelligence, human-machine collaboration, educational application, ethical principles, smart technology, smart education, big data, machine learning, talent training, and deep learning, which are considered to be the current hot spots of research. In summary, it can be considered that the research hotspots include intelligent education technology and application, human-machine collaboration in the age of intelligence, and intelligent education ethics.

2). From the results of the analysis of the author collaboration network, Gu Xiaoqing, Li Shijin, Wu Yonghe, Liu Bangqi, Zheng Yonghe, Wang Yiyan and Huang Ronghuai have published more articles, but have not yet formed a core group of authors. At the same time, the corresponding authors should also increase their cooperation and have connections with each other, which can promote better information sharing and systematic cooperation among researchers, which will also become a trend and strengthen the connections among scholars to help the forward development of related research.

3). From the results of the analysis of the author's institutional network, the research on the application of intelligent education is mainly based on teacher training universities. The most researched are East China Normal University, South China Normal University, Beijing Normal University and so on, but the connection between universities is not close enough, cooperation is relatively small, and many universities are independent research.

4). From the keyword clustering results, in the past six years, artificial intelligence has been integrated into many fields, and numerous keywords have formed nine major clusters, making it a hot issue for research since 2022. These research hotspots have also pushed the researchers behind to dig deeper into the mysteries and make more contributions to better intelligent education in China.

5). From the highlighted keyword results, "deep learning" "smart education" "learning analytics" "knowledge graph ", "education ethics", "future education", "smart divide", "digital intelligence integration "Emotional Computing" and "Smart Era" will be the research trends of smart education in China.

5.2 Outlook

A general analysis of the current situation of intelligent education research in China shows that intelligent education in China has made certain developments in research areas and research technologies in recent years. In the context of the current development, there are certain shortcomings in China's intelligent education research: intelligent education research has not yet formed an independent institutional system, nor has it yet formed a systematic, high-impact core research node, and the integration of artificial intelligence and education still needs to be deepened. Therefore, the following points are worthy of attention and consideration.

1). To further improve the deep integration of AI and education. The study of the deep level integration of AI and education involves a wider range of areas of content and academic levels, etc. The different stages of development of AI education have created different types of levels of integration of AI and education [18]. The deep integration of AI and education has helped improve the effectiveness of education and teaching, and also accelerated the reform and innovation of education in China. With the support of AI technology, the way of training talents, education and evaluation in primary and secondary schools, higher education institutions and vocational institutions will be more intelligent. However, with the continuous development of AI technology, the education and teaching requirements and standards for AI education have also changed, and subsequently new requirements have been put forward for the deep integration research of AI education. Therefore, further integration of AI and education is still needed.

2). Teachers should improve their intellectual education literacy. In the development of smart education, as students' sense of autonomy and creativity and their ability to collaborate with others increases, teachers are increasingly moving from being "saints on the podium" to "guides on the side". Students still need the corresponding coaching and guidance from their teachers when solving complex problems, exploring new areas and acquiring specific skills. [19]To this end, teachers should be equipped with the 'nurturing skills' of the smart age - organising and guiding students to think creatively, creating learning contexts adapted to different learning content, helping students to integrate internal and external knowledge resources, and equipping them with the awareness and ability to learn intelligently. Ultimately "establishing a learner-centred education environment, providing precisely pushed education services, and realising the customisation of daily and lifelong education".[20]

3). Universities and scholars should enhance cooperation and contact with each other more often to conduct research together. This will make future research on intelligent education in China more systematic and authoritative.

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