

Summary of Research on Intelligent Education in China in Recent Ten Years -Based on Co-Word Clustering Analysis

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ABSTRACT

In recent years, intelligent education has gradually become a hot topic in the field of educational informatics. With the help of SATI4.0 and SPSS22.0 software, this paper makes a visual analysis of the intelligent education literature samples from the perspectives of annual publication trend, major journals and research topics. The purpose is to illustrate the current hot spots and status quo of intelligent education research through data, so as to provide useful reference for the further development of intelligent education research. The results show that the current research on intelligent education is in the initial stage and generally on the rise, with interdisciplinary features. At the same time, there are still some problems in the research, such as the incomplete theoretical system, uneven research development in various fields, and weak research on the application of theory to practice. The future domestic education should be perfect intelligent education theory system, strengthen the practice research, and expand the study further breakthrough in breadth and depth of research.

Keywords: *intelligent education, co-word clustering analysis, visualization, overview of research*

1. INTRODUCTION

In recent years, the concept of intelligent education has been gradually emerging. According to the Outline of The National Medium - and Long-term Plan for Education Reform and Development (2010-2020), it is pointed out that in order to promote the modernization of education and build learning society, China must strengthen the construction of intelligent education, strive to create an intelligent education environment, and speed up the education reform.

The concept of "intelligent education" can be understood from two perspectives, one is informatization, the other is pedagogy. On the one hand, through the use of Internet technology, modern information technology and mobile terminals and other tools, the advantages of micro class, MOOC and flipped classroom are combined to create intelligent teaching environment and provide support for students' independent and personalized learning, so as to achieve the goal of intelligent teaching. On the other hand, it is necessary to discover students' potential in the process of intelligent teaching, which is no longer the simple knowledge imparting as traditional teaching, but the comprehensive quality cultivation with the cultivation of students' intelligence as the core. Specifically, is in a comprehensive modern information technology and learning theory as the instruction, with the auxiliary of "Internet plus" way of thinking and a new generation of information technology to explore the construction of new classroom teaching pattern, through the combination of modern information technology and education, promote the

digital and information technology education teaching, finally promote the development of students' comprehensive quality.

With the rapid development of information technology and the universal application of intelligent equipment, intelligent teaching has gradually become a new hot spot to deepen the current educational reform and is an inevitable choice to realize the leap-forward development of education. This paper selectively collates the research results of intelligent education in the core journals from CNKI periodical database in the past ten years (2011-2020), aiming to collate and explain the current research hotspots, development status and research trends in the field of intelligent education in China through visual analysis.

2. RESEARCH TOOLS AND DESIGN

2.1. The Data Source

Based on the domestic research results of intelligent education, the research object is from the literature of intelligent education collected in CNKI database. The specific selection criteria are subject retrieval of "intelligent education" by using advanced retrieval of CNKI journal library, the period is set as "2011 to 2020", and the source categories are "core journals" and "CSSCI". A total of 486 references were obtained through preliminary search, and irrelevant samples such as meeting minutes, content repetition and notification were manually eliminated, a total of 321 valid samples were obtained, and literature title

information was exported in EndNote format for subsequent analysis.

2.2. Research Design and Methodology

In this study, qualitative analysis and quantitative analysis are combined. Through high-frequency word statistics and co-word clustering analysis, the collected literature samples are quantitatively analyzed from the three dimensions of annual publication trend, main collection of journals and research topics, visual figures and tables are used to systematically analyze and integrate the text content.

The specific process is as follows: Firstly, the high-frequency keywords in the retrieved literature samples are processed by SATI4.0 software and the co-occurrence matrix is obtained. Through the co-keyword analysis, the research hotspots and structures of domestic intelligent

education are revealed. Then, based on the results of co-keyword analysis, a different matrix was generated, and SPSS 22.0 software was used for cluster analysis. Finally, the cluster structure tree diagram was obtained to reveal the research topics in various fields of intelligent education.

2.3. Research Tools

Data analysis and chart generation in this paper were obtained from SATI4.0, SPSS22.0 and Microsoft Excel 2019.

3. ANALYSIS OF RESEARCH RESULTS

3.1. Annual Publication Trend Analysis

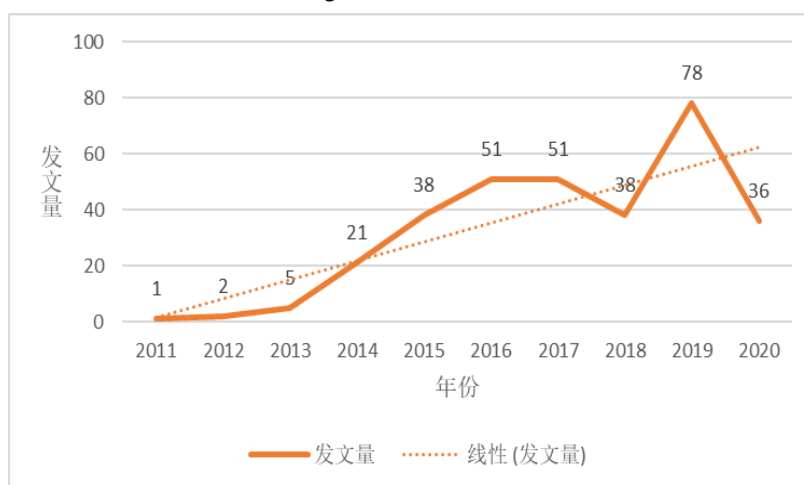


Figure 1 Statistical chart of annual publication volume of intellectual education research results

321 valid samples were retrieved from CNKI database, and the above data were divided into two stages, from 2011 to 2015 and from 2016 to 2020. There were only one or two published papers in 2011 and 2012, the publication volume in the first stage only accounted for 17.3% of the total. Since then, the number of published articles has increased year by year, with a large increase from 2015, a slight decline in 2018, and a small peak in 2019. The annual publication volume shows an increasing trend, which is basically consistent with China's educational reform policy and the development track of modern science and technology.

One of the earliest literatures came from Lu Qian's research on building an intelligent campus based on Cloud computing and the Internet of Things in 2011. Since then, the research content and scope have been constantly

expanded, from external environment construction to ontology theory development, application research and practice summary. The first stage is dominated by research on resource construction and exploitation design. Since 2016, ontology theory research and practical application research of intelligent education have been gradually emerging. Meanwhile, resource construction and exploitation design have also kept pace with The Times.

3.2. Main Collection of Journal Analysis

In order to have more detailed and in-depth understanding of the research status of intelligent education in China, this paper conducted statistics on the collected papers in source journals with the help of SATI4.0.

Table 1 Frequency Table of source journals (part)

The serial number	Source	Frequency	%	Cumulative %
1	China Educational Technology	59	18.3801	18.3801
2	Research on Audio-visual Education	41	12.7726	31.1526
3	Modern Educational Technology	40	12.4611	43.6137
4	Journal of Distance Education	12	3.7383	47.3520

Table 1, cont				
5	Distance Education in China	10	3.1153	50.4673
6	Modern Distance Education Research	10	3.1153	53.5826
7	Open Education Research	9	2.8037	56.3863
8	Journal of The Chinese Society of Education	9	2.8037	59.1900
9	Chinese Adult Education	9	2.8037	61.9938
10	Theory and Practice of Education	8	2.4922	64.4860
11	Chinese Vocational and Technical Education	8	2.4922	66.9782

The 321 articles were collected from 73 journals, 67% of which were collected from 11 journals. The publication volume of China Educational Technology, Research on Audio-visual Education and Modern Educational Technology accounts for 43.6% of the total samples. These journals are the core journals in the field of intelligent education in China. From the point of journal name, the most directly related research fields of these journals are pedagogy and information technology, especially the education technology core journal, suggests that education technology core journals are intelligent education important platform for researchers to study and communication, the development of modern information technology is an important driving force for the advancement of intelligent education research. In addition, due to the particularity of intelligent teaching environment and teaching mode, it has a good adaptability to students' practical operation and skill

training. Its research fields include but not limited to vocational education, higher education, school education and distance education, etc., showing an obvious interdisciplinary feature.

3.3. Research Topic Analysis

In this study, the software SATI4.0 was first used to analyze the high-frequency keywords in the current literature samples of intelligent education in China. With frequency greater than or equal to 5 as the screening condition, 26 high-frequency keywords and their frequencies were obtained (Table 2), and the co-occurrence frequency matrix and dissimilarity matrix were further generated by analyzing the high-frequency keywords in the research of intelligent education.

Table 2 High-frequency keywords and their frequencies

The serial number	Key fields	Frequency	%	The serial number	Key fields	Frequency	%
1	Intelligent Education	223	15.027	14	Core Literacy	9	0.6065
2	Educational Informatization	52	3.504	15	Information Technology (it)	8	0.5391
3	Big Data	29	1.9542	16	Intelligence	8	0.5391
4	Artificial Intelligence (ai)	21	1.4151	17	Education Reform	7	0.4717
5	Intelligent Campus	21	1.4151	18	Intelligent Era	7	0.4717
6	Intelligent learning Environment	15	1.0108	19	Intelligence Education	7	0.4717
7	The Internet	14	0.9434	20	Flipped Classroom	7	0.4717
8	Intelligent Study	14	0.9434	21	Cloud Computing	6	0.4043
9	Intelligent Classroom	14	0.9434	22	Teaching Mode	6	0.4043
10	Intelligent Class	13	0.876	23	Education Technology	5	0.3369
11	Study Analysis	10	0.6739	24	The teaching Design	5	0.3369
12	Modernization of Education	10	0.6739	25	Intelligent Teaching	5	0.3369
13	Personalized Learning	9	0.6065	26	Intelligent Curriculum	5	0.3369

By combining the results of high-frequency keywords and co-occurrence analysis, it can be concluded that the occurrence and co-occurrence of "Intelligent Education" and "Educational Informatization" are the highest. In addition, key fields such as "Big Data", "Artificial Intelligence", "Intelligent Campus", "Intelligent Learning

Environment" and "The Internet" are also appeared more frequently. The comprehensive study of education and modern information technology has become the top priority in the field of intelligent education, tools such as information technology and network resources are prerequisites for the existence of intelligent education. From

the framework of external learning environment to the combination of internal teaching concepts, the construction of intelligent curriculum and the design of teaching resources relying on advanced technology are becoming the hot spots in the field of intelligent education .The main trend of the development of intelligent education is to create intelligent environment, change learning mode and promote

the development and reform of intelligent education system by combining with modern information technology. Secondly, imported the dissimilarity matrix into SPSS22.0 for cluster analysis to generate the tree diagram. The vertical axis represents high-frequency keywords and the horizontal axis represents the distance between keywords, the shorter the distance between the two keywords, the higher their correlation is. The clustering results are as follows:

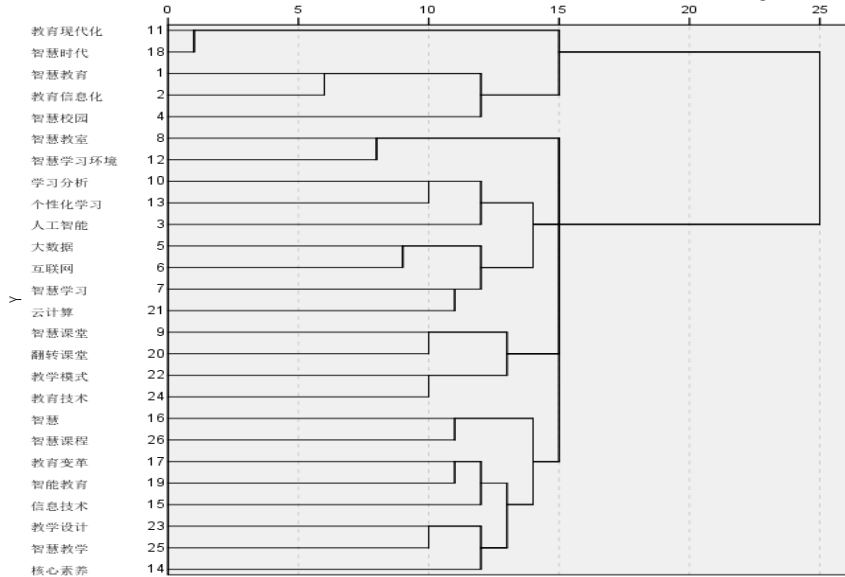


Figure 2 Cluster analysis tree

Table 3 Cluster analysis results

Subjects	Clustering results
Subject1	Modernization of Education, Intelligent Era, Intelligent Education, Educational Informatization, Intelligent Campus
Subject2	Intelligent Classroom, Intelligent Learning Environment
Subject3	Study Analysis, Personalized Learning, Artificial Intelligence, Big Data, The Internet, Intelligent Study, Cloud Computing
Subject4	Intelligent Class, Flipped Classroom, Teaching Mode, Education Technology
Subject5	Intelligence, Intelligent Curriculum, Education Reform, Intelligence Education, Information Technology, The Teaching Design, Intelligent Teaching, Core Literacy

By combining cluster analysis results and literature content, the current domestic research field of intelligent education can be divided into five research Subjects: ontology research of intelligent education, construction of intelligent learning environment, theory of intelligent learning, exploration of intelligent teaching mode and reform of intelligent curriculum.

3.3.1. Ontology research of intelligent education

Ontology research of intelligent education is the theoretical basis supporting the development of intelligent education. It focuses on the discussion of educational concepts such as the connotation, characteristics and pursuit of disciplinary value of intelligent education. Late with the innovation of information technology and the development of teaching practice, the intelligence of education began to combine

with new technology to discuss basic theory research, such as Xu Ye (2019) on the birth of new ecological intelligent education point of view, put forward from the artificial intelligence education transformation path towards intelligent education reality, for the intelligence of the era of injection into the new education development power, in order to provides a theoretical reference to promote the current education structural change. However, in general, a complete theoretical system of intelligent education has not been formed in China, and the technical research literature mostly focuses on model design. How to apply these new technologies to teaching activities still requires long-term practice of educators and further exploration by researchers.

3.3.2. Construction of intelligent learning environment

Intelligent learning environment, as a technical support for the realization of intelligent education, can provide intelligent learning diagnosis and learning services for learners according to their individual differences on the basis of learning analysis technology, and help learners' self-adaptation and personalized development. At present, the theoretical discussion and implementation strategy research on the system construction of intelligent learning environment are developing rapidly. With the support of new technology, the design of innovative teaching model and the empirical research on the teaching effects such as learners' learning experience and learning effectiveness have gradually become the hot spots, such as Xie Youru (2016) used the method of software development for reference, took electronic schoolbag as an example, constructed the generative intelligent learning environment, and carried out practice and other researches in the generative teaching of primary school Chinese. With the development and application of new technologies, the construction of new learning space, innovative teaching mode and intelligent learning support will become the research emphases of the future intelligent learning environment.

3.3.3. Theory of intelligent learning

Intelligent learning is an interactive learning process in which learners obtain resources through intelligent platforms to support and promote their personalized and comprehensive development, including studies on intelligent learning theory, learning environment, learning methods and learning evaluation. Such as Ma Xiangchun (2014) for junior middle school mathematics research building learning system model. This kind of research is mainly based on the big data analysis technology, combined with the advanced education concept, and provide personalized learning for students from the perspective of scientific strategy, generate learning evaluation, so as to fully meet the needs of personalized learning, cultivate learners with intelligence as the core of the development of the comprehensive quality. However, most of the current research on intelligent learning focuses on the relevant theoretical research on the construction and implementation of learning environment from the perspective of information technology, and there are few practical feedbacks on the design of learning mode and learning evaluation.

3.3.4. Exploration of intelligent teaching mode

Teaching mode exploration is the core element of intelligent education system and the basic approach of teaching theory to practical application. It can provide scientific practical basis for specific educational activities. In recent years, the number of papers on teaching mode design has increased

rapidly, indicating that intelligent education has started from theory to practice, and more and more researchers have begun to conduct practical application research on teaching mode in the intelligent era. Many scholars choose to reform the teaching mode with the help of modern technology, and take some specific curriculums as the object of practical research, such as the construction and application of the mixed teaching mode of University Russian in intelligent Classroom. Compared to traditional online classroom teaching, most of these designs are based on the creation and development of intelligent environment, advocate and pursue the new teaching concept of student-centered, teaching innovation, quality training and personalized learning.

3.3.5. Reform of intelligent curriculum

The current research about the intelligent curriculum reform in our country mainly includes two aspects: one is with the help of information technology platform to innovate the curriculum form, from traditional class teaching to offline teaching combined with MOOC, flipped classroom, micro class, etc, such as much involved in curriculum design and development. Its purpose is to promote the integration and sharing of knowledge resources and improve teaching efficiency. The other one is based on intelligent curriculum and existing educational theory and practical experience. For example, Chen Yaohua (2016) discussed the construction of intelligent curriculum, including its concept, connotation and value, aiming at cultivating learners' innovative thinking and creative ability, and promoting the reform of educational concepts. These studies have gradually shifted from the discussion of the connotation and system construction of intelligent curriculum to the combination of curriculum resources construction and development with specific disciplines. To a certain extent, it reflects the trend of practical development of intelligent curriculum.

4. CONCLUSION

Based on the content analysis of literature samples and the cluster analysis of co-words, this study studies the current situation and hot spots of the research development of intelligent education in China in recent ten years. The study found that the current domestic research on intelligent education is developing rapidly and showing obvious characteristics of interdisciplinary cooperative research. In recent years, empirical studies combining the theory of intelligent education with specific disciplines are gradually increasing, and theoretical discussions on teaching design and environmental construction are gradually transitioning to practice. A large number of excellent academic achievements have emerged in the detailed research in various fields under the intelligent education system. Among which the intelligent teaching mode design and

applied research have been developing rapidly, and are increasingly becoming an important research topic in the field of intelligent education.

Although the current research on intelligent education in China has made a series of achievements, as this field is still in the initial stage of development, it has many internal deficiencies, which are embodied in the following aspects: First, the theoretical system of intelligent education is not fully mature, and more in-depth systematic research is needed to support the development of methodology. Therefore, future research on intelligent education should focus on intelligent management, intelligent service, and intelligent evaluation, so as to form a complete intelligent education system. The second is uneven development of research in various fields of intelligent education. On the process of intelligent education, researchers pay more attention to the design of teaching process and the construction of the intelligent learning environment, the research on the intelligent management and teaching evaluation are relatively weak links. In the future, more attention should be paid to the expansion of the breadth and depth of research. The last point is the research on the application of current theory to practice is relatively weak. At the same time, it also points out the direction for future research. When theoretical research reaches a certain level, the focus should be shifted to practical application, so as to provide empirical evidence for theoretical progress while promoting practical development through theory.

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