Visual Analysis of Information Education Innovation Hotspots and Trends Based on Citespace

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Abstract. Through the visual analysis of the literature related to information-based education innovation, this paper discusses the research status, hot spots, frontier and development trend of information-based education innovation. CNKI database is the data source, "informatization" and "educational innovation" are the search subject words, the scientific metrology method is used and CiteSpace 5.8 R3 software carries out co-occurrence network visual analysis of literature authors, institutions and keywords. A total of 2354 related literatures are included, and Yang Zongkai, Chen Lin, He Kekang, Zhu Zhiting, Huang Ronghuai and Du Zhanyuan are the main authors; Central China Normal University, Beijing Normal University, East China Normal University, South China Normal University and the Ministry of education are the main research institutions; Innovation, informatization, educational innovation, information technology and innovative education are the most central research hotspots; education management, big data, higher vocational colleges, ideological and political education, innovation research, integration innovation, higher education and artificial intelligence are the research frontiers of information education innovation. Knowledge map analysis can intuitively and quickly show the development trend, research hotspots and cutting-edge contents of information education innovation research from 1999 to 2022, and provide reference data and development direction for further research.

Keywords: Informatization · Educational Innovation · Citespace · Knowledge Graph · Visual Analysis

1 Introduction

Informatization is to cultivate and develop new productive forces represented by intelligent tools based on computers. It is a technology based on modern communication, network and database, which summarizes the elements of the research object into the database for specific people's life, work, study, auxiliary decision-making and other behaviors closely related to human beings [2, 8, 11]. Educational innovation is an innovative activity in the field of education. The goal is to continuously improve the national

quality and cultivate high-quality, creative and all-round talents who adapt to social development. The rapid development of science and technology, the advent of knowledge economy and information society promote the reform and innovation of education industry. Informatization education innovation can greatly improve teaching efficiency, reduce costs, and provide scientific and technological support and material guarantee for promoting the progress of human society.

CiteSpace is an information visualization software developed by Professor Chen Chaomei. Under the Java environment, it can convert the literature data of informatization education innovation research into a visual knowledge map, and clearly reflect the development context, research hotspots, development trends of the research field [1]. This study applies the latest version of CiteSpace software to visually analyze the literature related to information-based education innovation, and intuitively reflects the research hotspot and development trend in the form of scientific metrology method and co-occurrence network knowledge graph, which is intended to have sufficient objective theoretical basis for analyzing the literature of information-based education innovation.

2 Data and Methods

2.1 Data Source and Data Processing

The data of this study comes from CNKI. The Chinese literature retrieval is carried out with "informatization" and "educational innovation" as the subject word. The retrieval period is unlimited, including academic journals, dissertations, conferences, newspapers and so on, with a total of 2447 documents. After eliminating duplicate documents, conference reports, newspapers, government or association project releases, a total of 2354 valid documents were obtained. The target file is exported from CNKI to the pre established input folder in Refworks format by the author, and the file format is renamed download-01, which can be run by CiteSpace TXT file.

CiteSpace 5.8 R3 software is used for processing, set time is sliced from 1999 to 2022, years per slice as 1 year, selection criteria top 50, select pathfinder and sliced networks are pruned, and finally statistical data and knowledge graph are obtained. In the co-occurrence network diagram, nodes represent authors, institutions and keywords in the literature; node size indicates frequency; the connection of nodes represents the co-occurrence relationship, and the thickness of the connection indicates the co-occurrence intensity; the color from purple to yellow indicates the change of time in the morning and evening; the centrality reflects the importance of nodes in the network structure; the network density reflects the tightness of the co-occurrence network structure [1].

3 Results and Analysis

3.1 Basic Characteristics of Literature

3.1.1 Annual Distribution of Literature

The annual number of documents issued can dynamically reflect the research trend of documents related to informatization education innovation. Figure 1 shows the change
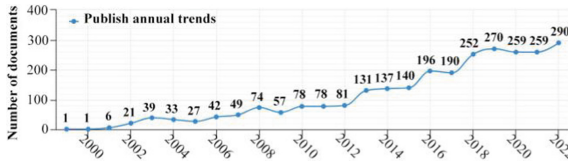
Fig. 1. Changes in the number of documents issued by informatization educational innovation research from 1999 to 2022.

of the number of documents issued on CNKI with the theme of "informatization" and "educational innovation" over the years. It can be seen from the figure that the number of articles published from 1999 to 2022 generally showed an upward trend. The first article retrieved is *The innovative service of China basic education vocational education information network to China's education and its contribution to world informatization* published by Wang Jihua in July 1999 [9], which showed that China's basic education vocational education information network was under the guidance of the central work of the Ministry of education, with the theme of "rejuvenating the country through science and education", macro service to administrative leadership, micro service in education and teaching, its appearance and the way of information deep processing fill the gap in the field of information service in China, and promote the innovation process of educational modernization in China.

Through the analysis of scientific measurement data, it is found that the research content of informatization education innovation is very extensive, covering the fields of ideological and political education, innovation and entrepreneurship education, information technology, higher vocational colleges, big data era, smart education, internet+, etc., which is one of the important factors for the increase of document issuance year by year. In 2011, the Ministry of Education issued the notice of the action plan for reform and innovation of secondary vocational education [7]: in order to seize the commanding height of economic development, the state needs to further adjust the economic structure, increase investment in education and science and technology, cultivate new economic growth points, build new competitive advantages and create new jobs through talent training and scientific and technological innovation. This notice has injected new vitality into the field of information education innovation and promoted the enthusiasm of academic researchers.

3.1.2 Author and Institutional Analysis

Through the analysis of authors and institutions by scientific metrology method, Fig. 2 shows the top 20 authors and their institutions. The more documents, the greater the contribution rate of individuals to the innovation research of informatization education. It can be seen that the largest number of articles issued by Yang Zongkai is 10, accounting for 10.64%; Chen Lin published 8 articles, accounting for 8.51%; He Kekang and Zhu Zhiting both published 7 articles, accounting for 7.45%; Huang Ronghuai and Du Zhanyuan both published 6 articles, accounting for 6.00%. Among the top 20 authors, 4 belong to central China Normal University, which shows that the contribution rate of individual documents issued by this university is high.
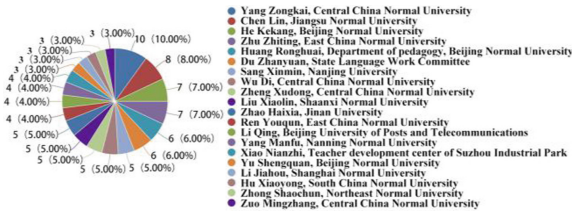
Fig. 2. Top 20 authors and their institutions of informatization education innovation research from 1999 to 2022.
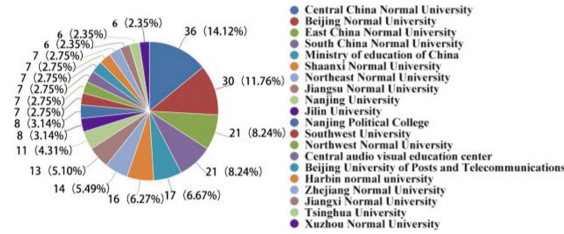

Fig. 3. Top 20 institutions in the number of documents issued by informatization education innovation research from 1999 to 2022.

The number of papers issued by research institutions reflects the research space and power distribution in the academic field. Figure 3 shows the top 20 research institutions with the largest number of papers. From the ranking of the publishing institutions, it can be seen that Central China Normal University has the largest number of papers, 36, accounting for 14.12%; Beijing Normal University has 30 articles, accounting for 11.76%; There were 21 articles in both East China Normal University and South China Normal University, accounting for 8.24%; The Ministry of Education issued 17 articles, accounting for 6.67%. The first four universities are key normal universities directly under the Ministry of education, which play an important leading role in the innovation research of informatization education. Central China Normal University has a National Engineering Research Center for educational big data application technology, which has brought great impetus to the number of documents issued by its informatization education innovation research. China's Ministry of education is in charge of education and language work. It has an authoritative and representative voice in the field of educational innovation and promotes the all-round informatization reform of education.

3.2 Keywords Analysis

3.2.1 Keywords Co-occurrence Network

Keywords are the concentration and refinement of the core content of literature. High frequency keywords can effectively reflect the research hotspots in specific fields (Li and Chen 2016). This paper uses CiteSpace software to conduct full-text search with the theme of "informatization" and "educational innovation" from 1999 to 2022, and generates a keyword co-occurrence map with 637 nodes, 967 connections and a network

Fig. 4. Key words co-occurrence of informatization education innovation research literature from 1999 to 2022.

Table 1. Key words in the top 20 of the research literature on informatization education innovation from 1999 to 2022.

Serial number	Keyword	Centrality	Frequency
1	Innovate	0.21	257
2	Informatization	0.15	219
3	Educational innovation	0.18	118
4	Information technology	0.12	82
5	Innovative education	0.12	69
6	Wisdom education	0.08	61
7	Colleges and universities	0.02	58
8	Colleges and universities	0.04	52
9	Big data	0.04	50
10	College student	0.04	49
11	Higher vocational colleges	0.02	48
12	Vocational education	0.03	44
13	Innovation and entrepreneurship	0.02	37
14	Internet+	0.02	37
15	Education management	0.03	36
16	Personnel training	0.03	35
17	Smart campus	0.04	32
18	Higher education	0.07	32
19	Teaching model	0.04	31
20	Education	0.02	28

density of 0.0048, as shown in Fig. 4. Get the top 20 high-frequency keywords, see Table 1. The higher the frequency of keywords, the larger the node display; The greater the centrality, the stronger the importance of the representative keywords in the network. The value of centrality greater than 0.1 is the key node.

The words with high frequency and strong centrality are innovation, informatization, educational innovation, information technology, innovative education, wisdom education, colleges and universities, innovative development, big data, college students, etc., which are the hot fields of research in recent years. Among them, the centrality of innovation, informatization, educational innovation [4], information technology and innovative education [3] is greater than 0.1, which has higher intermediary centrality. The research year is early, and the importance of keywords continues to this day. Innovation is the soul of national progress. Traditional educational concepts restrict the development of national innovation in China. Information technology can provide scientific, efficient and intelligent support for educational innovation. Innovative education is the core of educational reform, we can use educational technology, optimize the combination of educational resources, organically combine the theories of talents, pedagogy, creativity, psychology and other related disciplines, and help students establish innovative aspirations, develop innovative thinking, and cultivate innovative spirit and innovative ability through school classroom teaching and extracurricular activities.
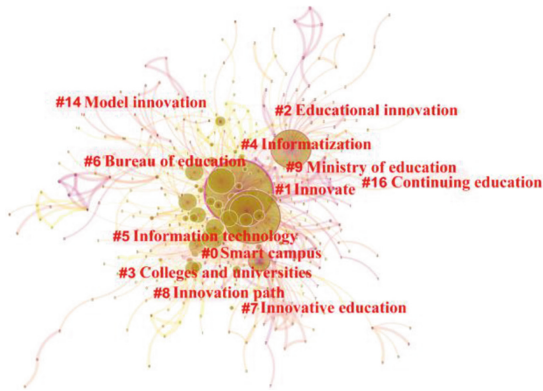
3.2.2 Keywords Cluster Analysis

On the basis of keyword co-occurrence, cluster analysis is carried out for high-frequency keywords, as shown in Fig. 5. CiteSpace can judge the effect of clustering structure and clarity according to the two indexes of module value Q and average contour value S. The clustering module value in this map is 0.645 (Q > 0.3), indicating that the network structure is very significant; The average contour value of clustering is 0.858 (S > 0.7), indicating that the internal research topics of clustering are clear and centralized and have high reliability.

From the clustering results, it can be seen that the research on informatization education innovation has formed a total of 12 effective clusters, including smart campus, innovation, education innovation, colleges and universities, informatization, information technology, education bureau, innovative education, innovative path, ministry of education, model innovation and continuing education. It is generally believed that the clustering effect is better when the number of cluster documents is greater than 10, and the clustering effect is worse when the number of cluster documents is less than 10. Table 2 is the statistics of keyword clustering data with the number of cluster documents greater than 10. Identifier is a high-frequency key word in the cluster, which reflects the key research field and research direction of the cluster, and can provide enlightenment and reference for researchers of informatization education innovation.

3.2.3 Keywords Emergent Analysis

The keyword emergence chart can clearly reflect the research frontier and evolution trend within the research years, and strength reflects the heat of research. As can be seen

Fig. 5. Keywords clustering of informatization education innovation research literature from 1999 to 2022.

Table 2. Keywords clustering data statistics.

Cluster number	label	Number of documents	Identifier
0	Smart campus	55	Smart campus, Artificial intelligence, Wisdom education, Summit, Educational technology
1	Innovate	54	Innovate, Higher education, Information age, Military education, Information literacy
2	Educational innovation	49	Educational innovation, Innovation ability, Teacher education informatization, Normal university, Innovate
3	Colleges and universities	49	Colleges and universities, Big data, Education management, College student, Higher vocational colleges
4	Informatization	47	Informatization, Teaching model, Preschool education, Development, Preschool education
5	Information technology	41	Information technology, Education and teaching, Vocational education, Innovation development, Integration innovation
6	Bureau of education	35	Bureau of education, Innovative application, Guangdong province, Innovative practice, Innovate
7	Innovative education	33	Innovative education, Innovative consciousness, Educational model, Vocational college, Middle school

(*continued*)

Table 2. (*continued*)

Cluster number	label	Number of documents	Identifier
8	Innovation path	31	Innovation path, Higher education, Teaching innovation, Operational research, Secondary vocational education
9	Ministry of education	26	Ministry of education, Ideological and political education, noc, Innovation mode, Primary and secondary schools

from Fig. 6, 25 words appeared from 1999 to 2022. Educational innovation (9.28), colleges and universities (7.66), innovative education (7.5), education management (6.66), ministry of education [5] (6.41) is the top 5 key words of outburst intensity, it shows that researchers have the highest interest in this kind of keyword in the innovation research of information education. Colleges and universities are important research bases for the implementation of educational innovation and educational management. Innovative education is conducive to breaking away from traditional education methods and promoting students' learning enthusiasm and creative enthusiasm. The Ministry of Education has played a key role in promoting educational reform and innovation.

Innovative education, innovation ability (3.62), innovative talents (3.52) is the keyword with the longest emergence time. Innovative education [3] focuses on studying and solving the problem of how to cultivate primary and secondary school students' innovative consciousness, innovative spirit and innovative ability in the field of basic education. Innovation ability [6] is the ability to continuously provide new ideas, theories, methods and inventions with economic value, social value and ecological value in the field of technology and various practical activities. Innovative talents [12] are those who have innovative consciousness, innovative spirit, innovative thinking, innovative knowledge, innovative ability and good innovative personality, obtain innovative achievements through their own creative work, and make innovative contributions to social development and human progress. The importance of these three key words is particularly prominent in the innovation research of informatization education, which provides a development opportunity for ideological and political education, innovation and entrepreneurship.

Among them, education management [13], big data, higher vocational colleges, ideological and political education, innovation research, integration innovation [10], higher education and artificial intelligence [14] are the research frontiers of informatization education innovation. In the context of the cloud era, big data (6.11) and artificial intelligence (3.41), as the products of the development of the high-tech era, have become important tools and specialized technologies for educational innovation and informatization processing, and play an important role in adapting to massive, high growth rate and diversified information assets.
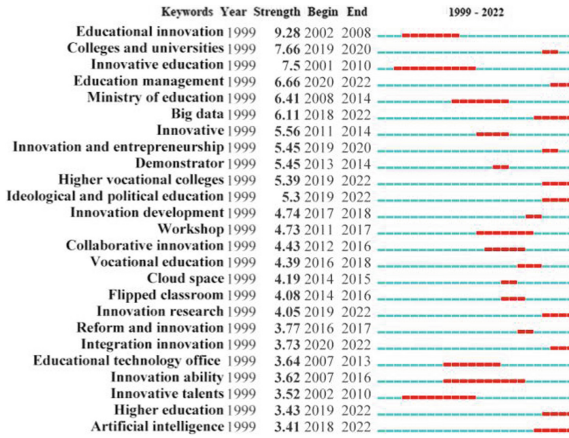
Fig. 6. Top 25 keywords with the strongest citation bursts about informatization education innovation from 1999 to 2022.

4 Conclusions

This paper makes a visual analysis of the subject literature of informatization education innovation research in CNKI database from 1999 to 2022 by using scientific metrology method and CiteSpace knowledge map software. The results show that:

- The annual volume of documents has shown a steady and rapid growth trend, and the research field is wide and extensive. The Ministry of Education has a great influence on the number of documents issued;
- Yang Zongkai, Chen Lin, He Kekang, Zhu Zhiting, Huang Ronghuai and Du Zhanyuan are the main authors; Central China Normal University, Beijing Normal University, East China Normal University, South China Normal University and the Ministry of education are the main research institutions;
- Innovation, informatization, educational innovation, information technology and innovative education are the most central research hotspots; Smart campus, innovation, educational innovation, colleges and universities, informatization, information technology, Education Bureau, innovative education, innovative path and Ministry of education are important keywords; Education management, big data, higher vocational colleges, ideological and political education, innovation research, integration innovation, higher education and artificial intelligence are the research frontiers of informatization education innovation.

In view of the current research progress, the following three suggestions are put forward for the future innovation research of informatization education:

- Normal universities are important research institutions that export innovative education, innovative ability and innovative talents. Central China Normal University

can give full play to the role of the National Engineering Research Center of educational big data application technology. Major research institutions, authors, education bureaus and troops can strengthen academic exchanges and cooperation or pilot practice of educational innovation. Advanced units can lead the development of information-based education innovation as demonstrators;

- China's Ministry of education needs to carry out seminars and academic exchanges in various fields and directions, and adhere to deepening educational reform and innovation. While maintaining the original excellent teaching system, we should introduce advanced education methods and teaching technologies from other countries, and strive to build a more complete, more efficient, more intelligent education system in line with the all-round development of our students through educational innovation in the information age, so as to lay a solid foundation for promoting the modernization of education, building an educational power and running an education satisfactory to the people;

- The transformation of contemporary education is based on modern information technology. The role of Internet+, big data and artificial intelligence can boost the development trend of educational resource informatization, object individuation, mode diversification, opportunity fairness, system life-long and functional socialization. Realizing the comprehensive innovation of education in the information age can provide advanced technical support for cultivating high-quality and all-round development talents, and bring guarantee for innovation and entrepreneurship and social progress.

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