Review and Prospect of Educational Innovation Research in China—Visual Analysis Based on CiteSpace

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Abstract. Taking the 373 literature on the topic of educational innovation from 2003 to 2023 in the CSSCI database in CNKI as the research object, with the help of CiteSpace software, combined with bibliometrics and visualization methods, the current study conducts a comprehensive analysis in terms of the time of publication, publishing institutions, publishing authors, and keywords of publication, and so on. It is found that there is no core research group and research institution, nor a unified research cognition and system in educational innovation. The research hotspot tends to be fragmented and decentralized, and it is necessary to further deepen the research of educational innovation.

Key words: educational innovation; knowledge map; CiteSpace; technology; digitization

1 Introduction

Education is essential for society to survive and thrive as a social institution that serves the needs of society, as well as one of the basic needs of human beings and a way for people to achieve their goals [1]. Innovation is a common concern in all fields of knowledge and is a central driving force in education forever [2], and the lack of innovation has far-reaching economic and social consequences [3]. Educational innovation is the introduction or incorporation of new elements, new situations, new processes, or new people into educational work in order to modify, improve, replace, or change some or all educational practices [4], and the current need for educational innovation has become urgent.

In this study, the CiteSpace software is used to conduct a bibliometric analysis of research results related to educational innovation from China. By drawing and analyzing the knowledge map related to educational innovation, it visually presents the thematic development, law, and future trend of educational innovation research, explores new contents, hotspots, and directions for subsequent educational innovation research, and provides support for further promoting the higher quality development of educational innovation.

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2 Research Design

2.1 Research Tool

CitesSpace is a computer program for scientific and technical text mining and visualization analysis that uses citation analysis theory. The software has the ability to predict the evolution of disciplines and frontiers of knowledge, its unique time-zone view and mutated word detection functions could provide detailed categorization and analysis of literature information [5]. Systematic reviews or research review papers based on CiteSpace software analysis have been conducted in broad fields of studies, specifically, in the education field [6]. However, there is a lack of systematic review on educational innovation review, which plays a significant role in the modern world, to visualise the growth of educational innovation. In the current study, CiteSpace 6.2.R6 was used to conduct a comprehensive analysis of the literature on educational innovation in China, which includes the institutions, authors, and keywords. Through these functions, China's educational innovation development process and future trends can be more completely displayed.

2.2 Data Source

This paper utilizes the CSSCI database from China National Knowledge Infrastructure (CNKI, http://www.cnki.net/index/) as its data source which is the most authoritative search platform for academic papers in China. Based on the advanced search function of CNKI, the paper searched for "educational innovation" as "Topic" and "Keyword". Figure 1 demonstrates 373 social science articles that resulted from the CSSCI database search between 2003 and 2023.

Then removed all the anonymous authors from the list as the unidentified information would not contribute to current analysis and these missing data might repeat the same year of publication with the unidentified information set by publishers. The identified educational innovation research studies from the CSSCI database were imported to CiteSpace analysis for detecting citation bursts, tracking evolution of educational innovation field into cluster view and time-zone view. According to Chen (2006), the burst terms could retrieve from authors, institutions, keywords, and the frequency of the term bursts over time. Figure 2 shows the setup for CiteSpace analysis, where the time slicing was set to divide 2 timespan from 2003 to 2023 into a series of smaller windows.

Data: 12 Oct 2023

Results: 373 *(from CSSCI)*

You searched for:

TOPIC: ("educational innovation")

Refined by: RESEARCH AREAS= Social Science, TYPES= Article, Timespan=2003-2023

Figure 1. CSSCI database search result for the topic educational innovation

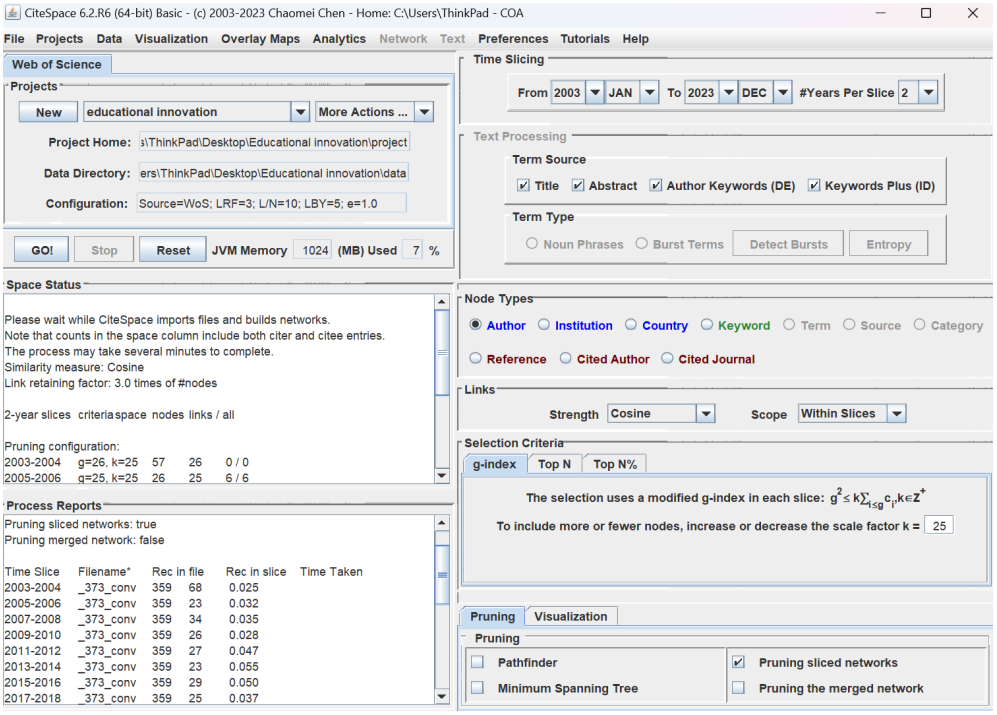

Figure 2. Set-up for CiteSpace analysis

3 Data Results and Analysis

3.1 Study Authors Analysis

The co-occurrence analysis knowledge graph of literature authors is shown in Figure 3, the graph has 136 nodes and 83 connections. The network density number is 0.009, suggesting that scholars within the educational innovation research field have established relationships, however, most of the scholars have limited cooperation with one another, resulting in dispersed research. The core network for educational innovation research is still unclear. Additionally, only Li Jianping, Tan Huiling, Yang Fei, Ma Xiaoling, Yang Xu, Wu Kangning, Dong Lili, and Li Qing have 2 publications. Wu Yonghe is the only author with more than 4 publications in the educational innovation research field, yet his publication volume represents just 1.11% of the total publications. This suggests weak academic connections among the various teams and authors in this field, and the absence of a core group of authors.

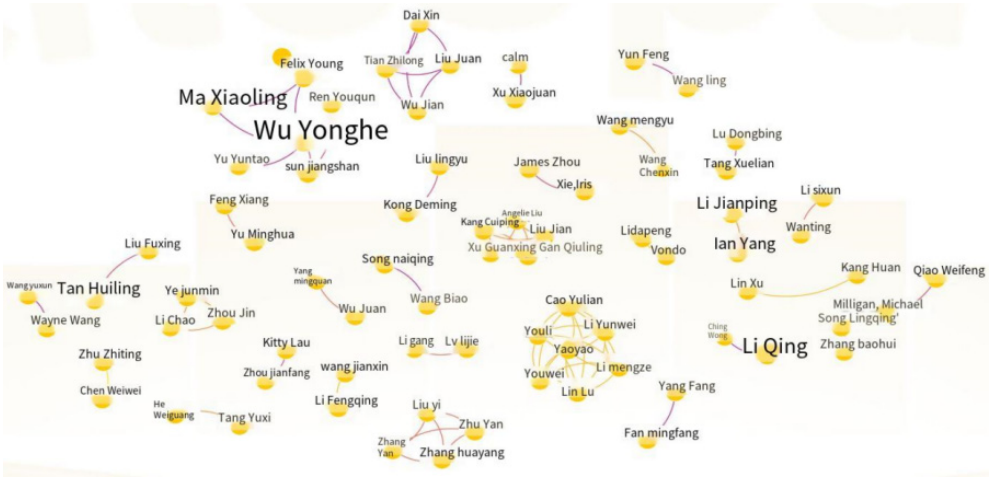

Figure 3. Cooperative atlas of Chinese educational innovation authors.

3.2 Institutional Analysis

The co-occurrence analysis of literature issuing institutions knowledge graph is shown in Figure 4, it is observed that the graph has 123 nodes and 66 connections, with a low network density of only 0.0088. These findings suggest that the connection among issuing institutions within the educational innovation research field is weak, signifying the need for further promotion of academic communication and cooperation among various institutions. East China Normal University Educational Information Technology Department has the highest number of articles, with a total of 5 publications, only 5 institutions have 3 or more publications, and most institutions conducting research on educational innovation are concentrated in leading educational regions like Beijing and Shanghai. These regions are also more active in educational innovation, suggesting a strong correlation between educational innovation research and regional educational innovation activity.

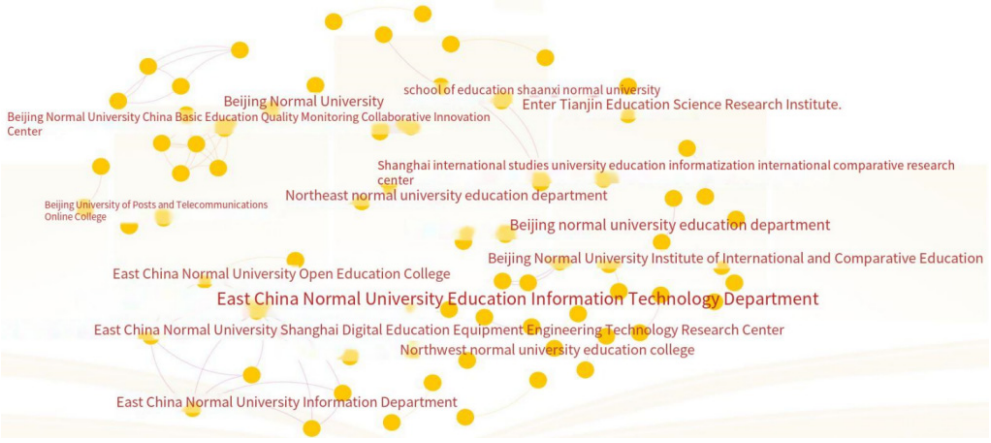

Figure 4. Atlas of China's educational innovation research institutions

3.3 Keywords Analysis

Keywords serve as the basic components utilized to present a thesis's main ideas. Conducting a keyword co-occurrence analysis can facilitate the recognition of potential connections between these ideas [5]. The outcome of such an analysis includes a clear representation of the most prominent terms within a given research field, which can be used to identify hot topics.

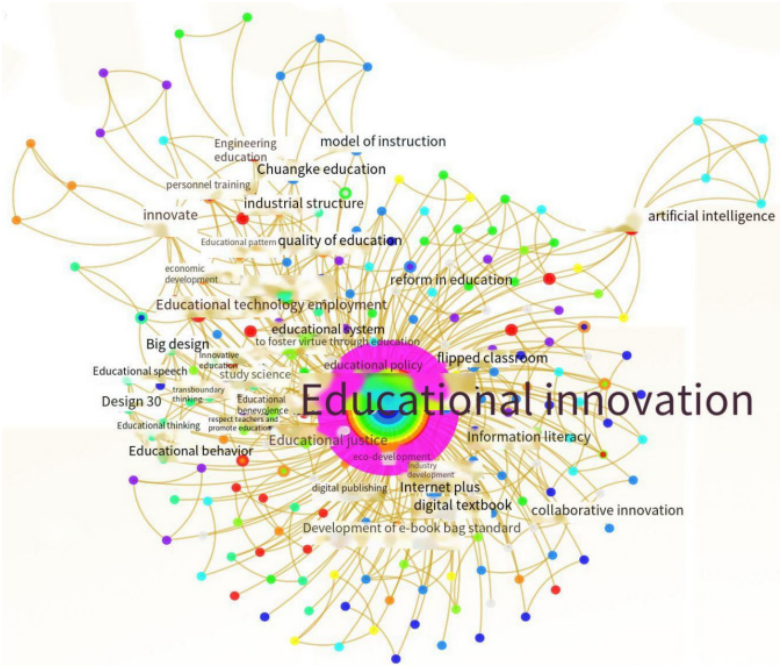

Figure 5. Atlas of China's educational innovation keywords

From the keyword co-occurrence analysis knowledge map in Figure 5, the top 10 keywords ranked by co-occurrence frequency are "educational innovation", "educational reform", "education informationization", "innovation", "innovation education", "talent cultivation", "higher education", "undergraduate", "engineering reform", and "educational reform". Educational innovation is a core theme and content and educational reform is a necessary means to achieve it. The comprehensive utilization of educational informationization is the primary form of educational innovation [7], with undergraduates being the primary target audience [4]. Innovation education is mainly implemented at the higher education level [8]. Within engineering education, educational reform is the primary focus of innovation education [9]. The objective of innovation education is to develop talents, which is also its main task [10].

3.4 The Core Field of Educational Innovation Research in China

Keyword clustering analysis helps to understand the structure and content of research hotspots better in a research field [5]. Based on the log-likelihood ratio algorithm, the clustering analysis of keywords for educational innovation research postings resulted in a cluster mapping (see Figure 6) and a report (see Table 1). From the clustering module value

Modularity (Q value), Q = 0.5291 > 0.3, which means that the clustering structure is significant; from the clustering average silhouette value Mean Silhouette (S value), S = 0.959 > 0.5, and the silhouette value of each clustering is greater than 0.7, which means that the clustering is more reasonable and good. The first seven categories of keyword clustering for educational innovation are educational innovation, educational tradition, innovative thinking, information literacy, innovative education, talent cultivation, and artificial intelligence.

Table 1. Educational innovation research published keyword clustering report

ID	Cluster name	Size	Year	Top terms (log-likelihood rato)
#0	Educational innovation	1	2011	Educational innovation(7.41), undergraduate(4.93); innovation education(4.93), educational reform (4.93) and talent cultivation (4.93) etc.
#1	Pedagogical tradition	0.969	2005	Educational traditions (11.47), science education (11.47), knowledge economy (11.47), quality education (11.47) and curriculum reform (11.47) etc.
#2	Innovative thinking	0.953	2014	Creative thinking (11.76), innovation (11.76), maker education (11.76); engineering education (11.76) and new engineering (11.76) etc.
#3	Information literacy	0.983	2011	Information literacy (13.17), internet+ (13.17), undergraduate(9.42), flipped classroom(6.53) and information environment (6.53) etc.
#4	Innovation education	0.98	2012	Innovation education (20.6); educational reform (9.86); constructivism (6.75); creativity (6.75) and revolution in education (6.75) etc.
#5	Talent cultivation	0.986	2008	Talent cultivation (20.6), employment (6.75), economic development(6.75), industrial structure (6.75) and information literacy (6.75) etc.
#6	Artificial intelligence	0.992	2018	Artificial intelligence (15.74), big data in education (7.77), emotional mentoring system (7.77), mechine learning (7.77) and smart education (7.77) etc.

In terms of the average time dimension, the clustering of educational innovation research mainly focuses on the period between 2005 and 2023, which is due to the fact that in the political report of the 16th National Congress of the People's Republic of China (NCPC) in 2002 that "insist on educational innovation, deepen the reform of education, optimize the structure of education, rationally allocate educational resources, improve the quality of education and the level of management", which points out the direction of educational innovation in the new period. The political call for educational innovation has driven the in-depth reform of educational innovation and promoted the rapid development of educational innovation.

3.5 Analysis on the Frontier Problems of Educational innovation Research in China

Keywords node burst detection is an important indicator of research activity that helps to capture the explosive growth of research literature on a particular topic at a particular stage and the hot spots at the forefront of research in the academic community [5]. Using the Citation/Frequency Burst function of CiteSpace software, the keyword burst view of educational innovation research was generated. The first 20 emergent words are shown in Figure 7. It can be seen that the top three in terms of burst intensity are: quality education (1.94), educational technology (1.83), and educational reform (1.51). Among them, the

keyword "quality education" is the earliest to emerge and continues to emerge, which has had a greater impact on the field of educational innovation research. Academic research on educational innovation related to "education reform" has continued from 2011 to the present, and "education technology" has continued from 2017 to the present. Combined with the trend in the number of articles published on these topics, it is likely that these two keywords will continue to be important research directions in the coming period. In the past five years, the keywords "educational technology", "smart education", and "artificial intelligence" have been highlighted, reflecting the rapid development of information technology and digital technology. Combined with the push for restrictions during the COVID-19 pandemic, educators need to utilize new e-learning technologies to develop new curricula and pedagogical methods to better deliver instruction and enable students to complete tasks online [11]. In this context, technology-mediated teaching and learning has been promoted, providing opportunities for innovation in teaching technology, and advancing scholars' research on the technological aspects of educational innovation [9]. The above-emerging terms reflect important current themes and evolutionary trends in the field of educational innovation research over time, and the emergence of these themes is also closely related to the level of national technological development and related policy guidelines.

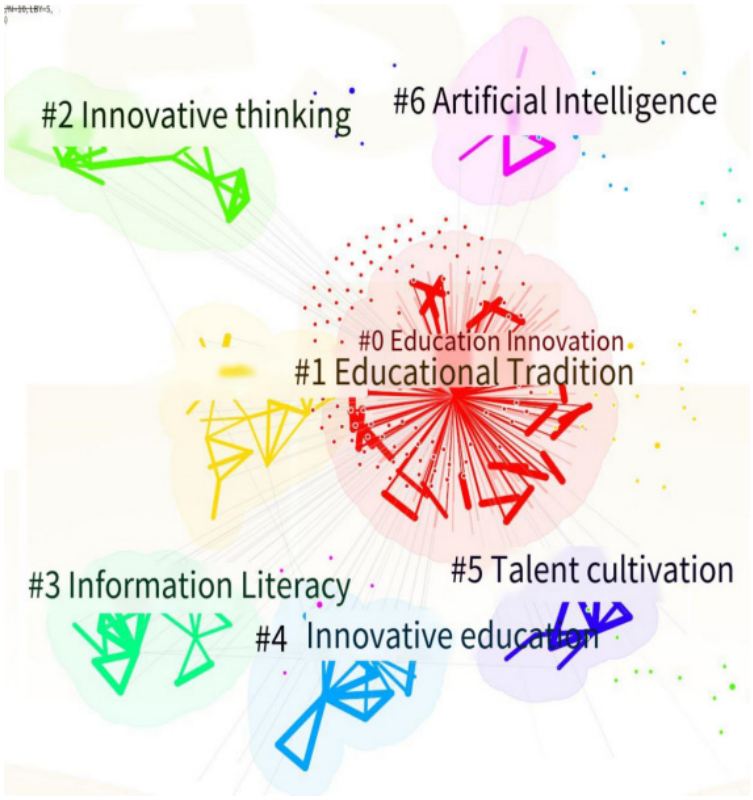

Figure 6. Atlas of China's educational innovation keywords

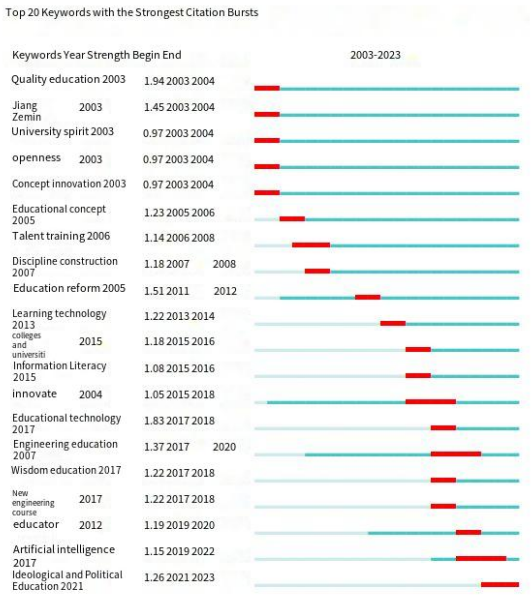

Figure 7. Top 20 Keywords with strongest citation bursts.

4 Conclusions and Future Work

Through bibliometric analysis, the current study shows the distribution of key researchers and research institutes in China on educational innovation, analyzes in depth the evolution of the attitude of the development of research in this field and the evolution of the theme, and draws the following conclusions:

(1) The visual mapping of author cooperation and institutional cooperation shows that the connection between nodes is sparse, indicating that the development of the field of educational innovation is not mature enough, and is generally in a state of fragmented research by individuals and small groups, and lacks recognized academic authority and national academic exchange and cooperation.

(2) According to the keyword co-occurrence network and time zone view, "educational innovation" is the most discussed topic among scholars, followed by "educational reform", "education informatization", "innovation", "innovative education", "talent cultivation", etc. In the course of time, it has passed through the initial exploratory stage, the stabilization stage, and the modern stage, and the research on educational innovation is gradually coming out of the purely theoretical discourse and starting to integrate with social context and practice.

(3) Throughout the development of educational innovation research, the research literature has introduced multi-theoretical perspectives to explore the evolution logic, development path, and operation mechanism of educational innovation, which has promoted the deep integration of theories, technologies, and concepts in the process of educational innovation, and effectively promoted the development of educational innovation. From the trajectory of related

policy changes, the government-led top-down mandatory policy has been transformed into a clear policy direction and collaborative cooperation between the government, schools, leaders, teachers, , and other subjects, which has gradually formed the educational innovation system. Through the process of educational innovation practice, it has shifted from pure policy support orientation to curriculum reform and in-depth integration with digital technology, forming a talent cultivation model that nurtures the spirit of innovation, innovative thinking, and innovation ability, and from single course innovation in schools to an all-round, multi-principal collaborative and integrated innovation cultivation mechanism that collects innovation resources in and out of school.

In order to meet the new needs of social development, the educational system has entered a state of change, and the importance of educational innovations has become the subject of widespread consensus [3]. Educational innovation refers to a departure from current educational practices involving novel practices, tools, technologies, knowledge, or ideas, which implies a fundamental shift in the educational paradigm, and it usually involves two different aspects of technology and stakeholders in education. Combining the above statistical analyses and conclusions on the evolution of research dynamics and the evolution of research themes, it can be found that the research on educational innovation still has certain shortcomings in terms of educational innovation technology, educational innovation method, and educational innovation environment, therefore, research on educational innovation can continue to be explored in the following three areas.

(1) The global community has entered the fourth industrial revolution, and emerging technologies such as artificial intelligence and big data have brought changes in the field of education while changing the way people live and work. In this context, information and communication technology brings us closer to the dissemination of knowledge and increases the opportunities to acquire skills and improve competencies. Technology-enabled teaching and learning is an innovation when technology is not just a tool that replaces traditional tools but is used to change existing practices. Educators have used new e-learning technologies to develop new curricula and pedagogical methods to facilitate better content delivery and enable students to complete tasks online. However, how to transform technology education innovation into teaching practice is a problem worthy of further research.

(2) Educational innovation aims to improve the quality of the educational process, and educational innovation activities include not only the learning of the participants in the innovation process but also the pedagogical methods of the implementers of the educational innovation process. Students should be encouraged to move away from a model of learning that focuses on information, memorization, and verticality, and develop a model of learning based on active learning methods, learning to learn, self-regulated learning, collaboration, and collaborative work. Therefore, teachers need to develop a new pedagogy to meet the advanced learning needs of a new generation of students. However, how to translate technological educational innovations into pedagogical practices is an issue that deserves further research.

(3) As the most fertile ground for educational innovation, schools are the source and dependence of educational innovation. Educational innovation is the key to achieving equity and improving the quality of outcomes in all education sectors, and the environment is an important factor in facilitating the diffusion of innovation. Innovative teaching and learning environments not only support better learning outcomes and improve the well-being of school

staff and students but can influence innovations in the education sector. Therefore, the impact of the organizational environment on educational innovation needs to be explored in depth. The success and sustainability of educational innovations are largely dependent on the support provided by educational institutions [12]. Thus far, there is a lack of research conducted by scholars regarding how to maintain the sustainability of such innovations.

In addition to the above, factors such as national education policy, student preparation, teacher competence, social environment, resources, science, culture, physical activity, internationalization, modern educational technology, and quality assurance also have an impact on educational innovation, and factors that inhibit or promote the development of educational innovations should be defined clearly in future research.

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