

Knowledge Atlas of Online Education Research in China Based on Visual Analysis

Xiao Xiao^{*a} and Guanghua Yang^{b}

School of business administration, Wuhan Business University, Wuhan 430056, China

Keywords: Online Education, Citespace, Visualized Analysis, Knowledge Map.

Abstract: By analyzing the situation of my country's online education research, we summarize the research hotspots and future trends, with the purpose of providing reference and reference for my country's online education innovation research. Combined with Citespace, this paper draws a scientific knowledge map of my country's online education research based on the online education related literature in the CSSCI database. It is found that my country's online education research is significantly affected by national policies and the new crown epidemic, the number of published articles shows a steady growth trend, and the research group is scattered. Therefore, scholars need to strengthen cooperation with institutions, further scientific and objective in-depth practice, and combine qualitative and quantitative research methods to promote a more comprehensive development of online education research.

1 INTRODUCTION

Compared with Western countries, China's online education started relatively late. Technically restricted by Internet technology; conceptually shackled by traditional classrooms, although various platforms and companies are trying their best to explore and move forward, the industry is developing slowly. In October 2019, 11 departments including the Ministry of Education jointly issued guidelines, proposing to promote the healthy development of online education. The new crown epidemic in 2020 has caused an unprecedented interruption of education services. The Ministry of Education called for "suspending classes without stopping school". The "China Education Modernization 2035" issued by the State Council clearly proposed to "accelerate the educational reform in the information age". Based on this, this paper uses Citespace software to analyze the literature on the theme of "online education" in my country in recent years, and presents the research progress through visual means, in order to provide decision-making reference for practical work.


2 RESEARCH METHODS AND DATA SOURCES


2.1 Research Methods

2.1.1 Scientific Collaboration Analysis

The research hotspots and frontiers in the field of "online education" are investigated through bibliometrics, and the evolution characteristics of research in this field are revealed in an objective, quantitative, direct and visual way through data mining and graph analysis, which can effectively avoid traditional literature research methods. Questions that are biased towards inductive reasoning and are too subjective.

This study uses Citespace's visual analysis of online education research, and uses a combination of quantitative and qualitative methods to cluster the knowledge base and keyword co-occurrence of the literature, and then analyze the research context and trends of online education.

^a <https://orcid.org/0000-0002-9577-9517>

^b <https://orcid.org/0000-0001-6150-2977>

2.1.2 Price's Law

The square root of the total number of scientists, produces 50 percent of all scientific papers. If the number of papers published by the most productive scientist is set as n_{max} , and the total number of papers published by scientists is denoted as $x(1, n_{max})$, price's law can be expressed as follows:

$$(1/2) \times (1, n_{max}) = x(m, n_{max}) = x(1, m) \tag{1}$$

Where, M is such a number assumed by Price, that is, the total number of papers published by scientists whose individual number of papers is greater than m is exactly equal to half of the total number of papers, and the meaning of $X(m, n_{max})$ in the equation exactly represents this half of papers.

Based on lowe's law and mathematical conclusion, price deduced that $m \approx 0.749(n_{max} / 2)$.

2.1.3 The K-Mean Clustering Algorithm

K-means is a clustering algorithm based on the partition of sample sets. K-means clustering divides the sample set into K subsets to form K classes, and divides N samples into K classes. The distance from the center of each sample to its class is the smallest, and each sample belongs to only one class. For large data sets, k-means clustering is relatively scalable and effective.

Given the data sample X , n objects are included $X = \{X_1, X_2, X_3, \dots, X_n\}$, Where each object has properties of m dimensions. The goal of the K-means algorithm is to cluster n objects into the specified k class cluster based on the similarity between the objects, and each object belongs to and only to one class cluster with the smallest distance from the center of the class cluster. For K-means, the k clustering centers need to be initialized first $\{C_1, C_2, C_3, \dots, C_k\}$, $1 < k \leq n$, Then, by calculating the Euclidean distance from each object to each cluster center, as follows:

$$dis(X_i, C_j) = \sqrt{\sum_{t=1}^m (X_{it} - C_{jt})^2} \tag{2}$$

In the above formula the X_i represents the i -th ($1 \leq i \leq n$) object, the C_j represents the j -th ($1 \leq j \leq k$) cluster center, the X_{it} represents the t -th attribute of the i -th ($1 \leq i \leq n$) object, The C_{jt} represents the t -th attribute of the j -th cluster center. Comparing each object from distance to each cluster center in turn, assigning objects to the class cluster from the nearest cluster center, yields k class clusters $\{S_1, S_2, S_3, \dots, S_k\}$.

The K-means algorithm defines the prototype of the cluster with the center. The cluster center is the mean of all the objects in the cluster in each dimension. The calculation formula is as follows:

$$C_t = \frac{\sum_{X_i \in S_1} X_i}{|S_1|} \tag{3}$$

In the formula, C_1 represents the center of the l -th ($1 \leq l \leq k$) cluster, $|S_l|$ represents the number of objects in the l -th class cluster, X_i represents the i -th object in the l -th class cluster, $1 \leq i \leq |S_l|$.

Therefore, the visual analysis of online education research in this paper mainly focuses on the clustering of knowledge base and keyword co-occurrence of the literature, and then analyzes the research context and trend of online education.

2.2 Data Sources

The data of this article comes from the Chinese Social Science Citation Index (CSSCI). Searching "online education" in the "all fields" method yields 314 search results. After manual screening, reviews, reports, etc. were removed, and finally 286 papers (1998-2022) with reference value were obtained as research objects, and the acquisition time was July 12, 2022. By systematically sorting and summarizing 286 literatures, it shows the history of online education research in my country.

3 RESULTS AND DISCUSSION

3.1 Analysis of Publication Time

An analysis of the time distribution of the number of publications is helpful to understand the degree of attention paid to online education research.

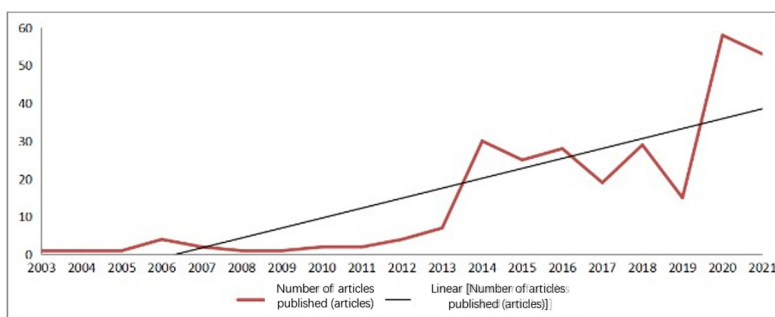


Figure 1: Time distribution of online education research in China.

As shown in Figure 1, the number of published papers on online education research in my country is on the rise, especially after 2014, and it will explode in 2020. 2003-2012 was the initial stage of online education research. Affected by the development of information technology, the academic circles paid less attention to this field, with fewer research groups, less research efforts, and few published papers. 2014-2019 is the development stage of online education research. Although it has grown rapidly, it has occasional ups and downs, and the fluctuations are not large. 2020 has been an explosive growth stage of online education research. Affected by the epidemic, the scope of online education has been continuously expanded, the forms of online education have become more diverse, the research field has been broadened, the research content has been in-depth, and the research methods have been diversified.

3.2 Author Analysis

By analyzing the author symbiotic collaboration network diagram, we can understand the important scholars in the field and their collaborations.

The knowledge map of author cooperation network in my country's online education research is

shown in Figure 2. The size of the nodes (solid circles) in the figure represents the number of documents. The larger the author's name is, the more the author publishes. The lines between the nodes represent the author's cooperation. , there are 271 nodes and 144 links in the figure, and the network density is 0.0039, which indicates that the cooperation between domestic researchers in the field of online education is not close. In this field, there is only a 7-person cooperation network headed by Cheng Jiangan and Han Xibin, and the rest of the people are scattered, and there are a large number of independent research scholars.

According to Price Law (Price Law): the total number of scientists square root, the number of people who have written 50% of all scientific papers. According to the number of nodes, the number of authors in the field of online education research is 271, so the number of core authors in this field should be $\sqrt{271} \approx 16$. However, more than half of the papers in this field have more than 16 authors, so there are no more authors in this field. No core author group has been formed.



Figure 2: Co-occurrence map of authors in online education research in China

3.3 Source Analysis of Important Journals

Academic journals are an important channel for the

dissemination of scientific research results. Co-citation analysis of journals can provide the distribution of important knowledge sources in a certain field.

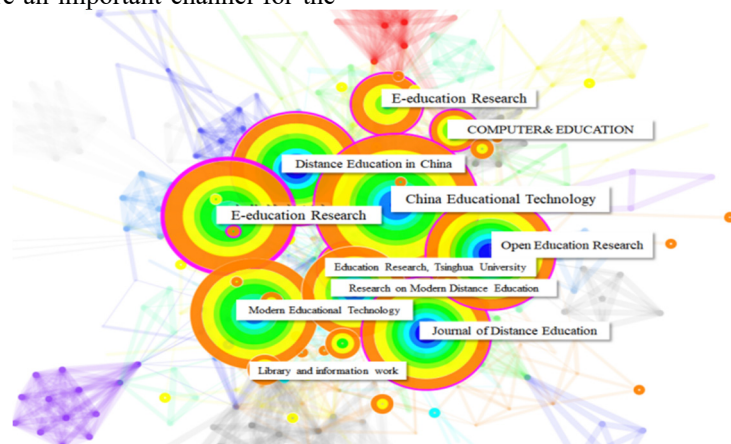


Figure 3: Journal co-citation network for online education research in China.

Citespace selected Cited Journal to obtain the co-citation network of journals in the field of online education in my country, as shown in Figure 3. There are 484 nodes in the graph, 1929 links, and a density of 0.0165. In Citespace, nodes whose centrality exceeds 0.1 are key nodes. It can be seen from the network of co-cited journals that "China Electronic Education" has the highest citation frequency, and the journals are mainly electronic education, which has a strong concentration.

The first stage of research on online education in my country is mainly in two aspects: on the one hand, through the analysis of the advanced experience of the United States and other university libraries, it is proposed to promote online information literacy education in my country and build a related education system, and its main development object is university books. The main purpose is to enhance the information quality of teachers and students; on the other hand, when China enters the Internet 1.0 era, it proposes to use the Internet to conduct research on distance education. The articles at this stage are few and scattered, limited by the limitations of the popularization of the Internet, the research mainly focuses on the feasible discussion and analysis of online education for a small number of groups or institutions, which belongs to the theoretical research stage.

3.4 Evolutionary Path Analysis

My country's online education research can be divided into three periods, the first stage is 2003-2012, the second stage is 2014-2017, and the third stage is 2019-present.

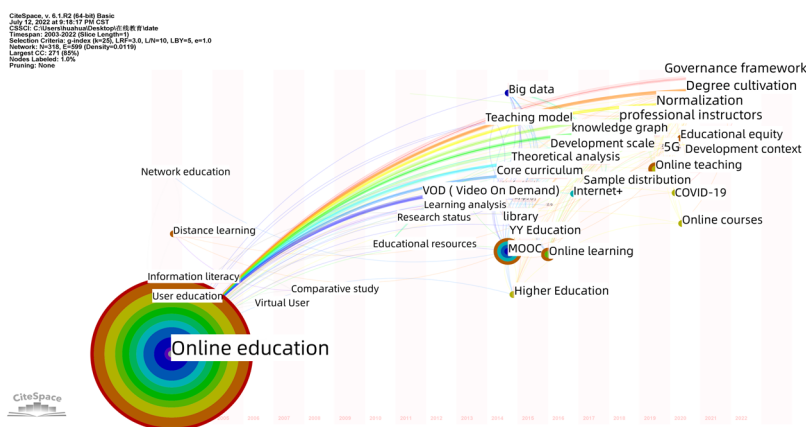


Figure 4: Evolutionary path of online education research in China

The second stage originated from the "Ten-Year Development Plan for Education Informatization (2011-2020)" issued by the Ministry of Education of China. The document proposed to "build an intelligent teaching environment, provide high-quality digital education resources and software tools, and advocate network inter-school collaboration learning and improving the level of information-based teaching". In 2010, my country's Internet development entered the era of 2.0, that is, the mobile Internet stage, with a large-scale increase in Internet users. In 2013, MOOC was introduced into China, setting off a frenzy on MOOC research, and proposed new development directions such as flipped classroom, open university, big data + online education development. This stage focuses on the practical exploration stage of large-scale online education platforms.

The third stage started with the global outbreak of the new crown epidemic. In order to curb the spread of the new crown epidemic, Chinese schools were suspended on a large scale, and online learning has become the only option for China to "suspend classes

and continue learning". Therefore, online education has once again ushered in a golden period of development, and scholars at this stage have begun to focus on research on the diversification of online education. The research is centered on online education, including four aspects: the implementation of teaching activities, the guarantee of teaching operation, the reform of education and teaching, and the balanced development of education.

3.5 Keywords Co-Occurrence Analysis

Keywords are the author's highly generalized and centralized description of the content of the literature. Co-occurrence analysis of keywords can reflect the research hotspots in this field to a certain extent. The keyword co-occurrence network knowledge map of my country's online education research is shown in Figure 5. There are 318 nodes, 599 chains, and a network density of 0.0119. The top 20 high-frequency keywords are extracted and sorted in descending order, see table 1.

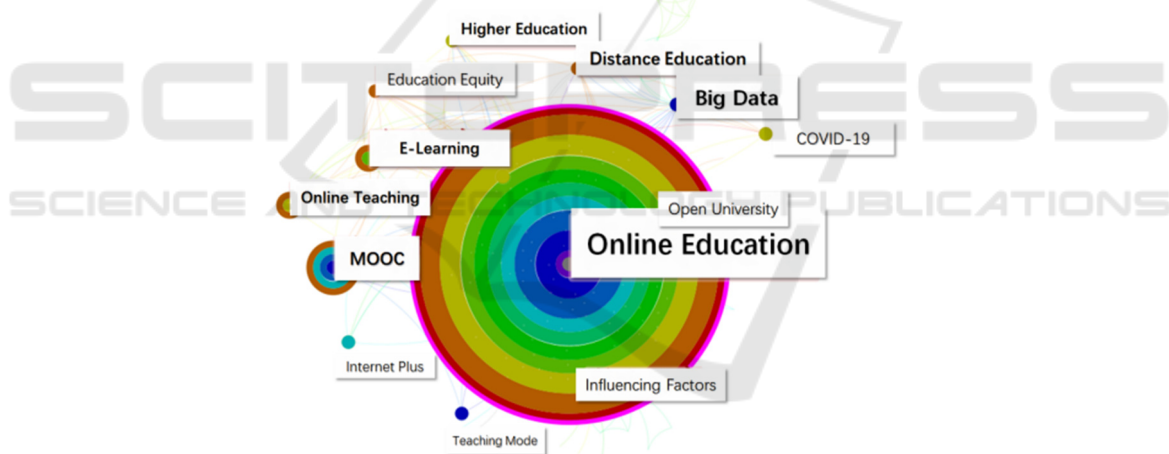


Figure 5: Keyword co-occurrence network of online education research in China

Table 1: Top10 keywords of online education research in China.

serial number	Frequency	keywords
1	208	online education
2	16	MOOC
3	12	Online learning
4	11	Big data
5	8	Higher education
6	7	The remote education
7	7	COVID-19 pandemic
8	7	Education fair
9	7	Online teaching
10	6	Factors affecting the

3.5.1 MOOC

With the rapid development of Internet technology and knowledge economy, and the popularity of the worldwide resource openness movement, massive open online courses "MOOC" have begun to emerge. Liu Hehai believes that the essence of "MOOC" is online education, and the key point lies in its "autonomy, collaboration, and interaction", which are embodied in three aspects: curriculum design, teaching philosophy, and learning process. (Liu, Zhang, Zhu, 2014) Wang Xiao and Wang Zhiqian believe that MOOCs have brought opportunities for the reform and development of teaching in my country's colleges and universities, but they have obvious limitations in teaching concepts, teaching processes and teaching effects. The positioning of courses in college teaching, the construction of excellent courses of MOOCs, and the teaching mode of flipped classroom for reference, realize the organic combination of MOOCs and traditional college teaching. (Wang, Wang, 2015)

3.5.2 Online Learning

Online learning is not simply to copy the offline classroom to online, but to understand its essence and connotation, through careful design and organization, and a new form of future education that organically integrates with offline classrooms. Huang Ronghuai and Zhang Muhua, from the perspective of super-large-scale Internet education organizations, clearly pointed out that smooth communication platforms, appropriate digital resources, convenient learning tools, diverse learning methods, flexible teaching organizations, effective support services, and close government-enterprise relationships. The seven elements of school collaboration are the basic guarantee for the smooth progress of online learning. (Huang, 2020) From the perspective of user experience, Liu Shu believes that learning platforms have a tendency to homogenize basic functions, and user experience will become an important driving force for the development of online learning platforms. (Liu, 2019) Miao Dongling, Wu Zhao, and Yan Hanbing constructed an influencing factor model of online learning from the perspective of comprehensive learning theory. They believed that the three dimensions of content, interaction, and motivation have a significant impact on the stickiness of online learning. (Miao, Wu, Yan, 2021)

3.5.3 Big Data

The "big data" produced with the transformation of computer and Internet technology provides a new opportunity for educational reform and the improvement of educational quality. Zhu Jiayi pointed out that educators, educational institutions and related managers should not overestimate the impact of big data on educational reform. Personal success is the result of a combination of factors such as family, society, and school. (Zhu, 2016) Wang Shuaiguo takes the smart teaching tool Rain Classroom as an example to discuss the development paths of colleges and universities to carry out teaching reform and use teaching tools to carry out blended teaching under the background of big data. (Wang, 2017)

3.5.4 Higher Education

Under the interactive influence of multiple factors such as information technology innovation, commercial value promotion and the development of educational equality and lifelong education concepts, modern information technology represented by artificial intelligence has triggered profound changes in the higher education ecosystem. Wang Cixiao pointed out that online education in colleges and universities is faced with three opportunities and challenges: innovation of educational service system, reform of talent training system, and structural development of educational resources. (Wang, 2020) Hu Dexin and Li Linlu pointed out that the multi-linkage of online education and higher education reform has triggered a profound revolution in learning methods and content, and promoted subversive changes in teaching methods, content and teams. (Hu, 2021) Zhang Nanxing believes that the construction of online higher education courses and their platforms in my country has a relatively high starting point in the past 20 years. There is a certain gap. (Zhang, 2021)

3.5.5 COVID-19 Pandemic

Affected by the new crown epidemic, the school closure policies of various countries have affected hundreds of millions of children and adolescents. In March 2020, the Organization for Economic Cooperation and Development conducted a global survey on how education systems are responding to the epidemic and the challenges faced by large-scale online education. The study found that the digital divide is exacerbating inequity in education; the epidemic has highlighted the social functions of

schools and put forward higher requirements for teachers' expectations; China has certain advantages in school resources and teachers' professional preparation for online education, but There is an imbalance in the distribution of resources among individual students. (Xu,2020)

4 CONCLUSIONS

4.1 Conclusions

Based on the online education-related research literature published by CSSCI from 1998 to 2022, and using the information visualization tool Citespace as the research method, this paper systematically studies my country's online education research from the aspects of publication time, authors and journals, research hotspots and evolution paths. analysis, the following conclusions are drawn:

The time distribution shows that the number of articles in online education research, especially after 2014, has shown a significant growth trend, indicating that the attention of this field is continuously increasing, which can be divided into three stages: slow development, rapid development and explosive growth.

The distribution of authors shows that the online education research groups in my country are small concentrated and scattered, with less group cooperation and more independent research. Only a cooperation network headed by Cheng JIANGANG and Han XIBIN is formed. At the same time, online education research institutions are scattered, with less cooperation, and most of them are Colleges of Education and Information Colleges.

The published journals show that online education research papers are mainly published in distance education, open education and education-related journals. These publications, such as "China Electronic Education", are highly authoritative journals in the field of online education, and their citation frequency is also high. The highest, "Electronic Education Research" has the highest centrality, and they are all knowledge carriers and important communication channels for online education research.

The analysis of keywords and evolution paths shows that the hotspots of online education research are mainly concentrated in MOOC, online learning, big data, higher education, distance education, etc. The research content is also drawn from foreign experience, the domestic macro-educational

environment, and developed into practical teaching strategies. Research.

4.2 Discussion

With the introduction and development of online education concept to popularization, the research on online education in academia has also experienced a development process from theory to practice, from macro to micro, and from simple to complex, but there are still shortcomings.

First of all, online education research generally emphasizes theory rather than practice, focusing more on macro-level and theoretical research, and less on tools and platforms that can effectively guide online teaching. Secondly, there are more qualitative researches and less quantitative researches in online education research, and the researches are more inclined to the proposal and solution of problems, with less effect and feedback. Finally, the number of researchers in online education is large but the number of leaders is small, the core research team has not yet been formed, and there is a lack of effective interaction between research institutions.

In the future, exchanges and cooperation among scholars should be strengthened to jointly promote a more comprehensive, in-depth, scientific and objective research on online education in my country.

ACKNOWLEDGEMENTS

We thank the fund for its support: The National Business Education, Training and Scientific Research "Fourteenth Five Year Plan" project in 2022"Ideological and Political Construction and Practice Research on Core Courses of E-commerce" (Project No. SKKT-22068).

REFERENCES

- Cixiao Wang. Development Venation, Application Status, and Transformation Opportunities of Online Higher Education [J]. *Modern educational technology*, 2020:5-14
- Dexin Hu. Crossover and integration: linkage mechanism and pattern reconstruction of online education and higher education reform [J]. *College education management*, 2021:77-86
- Dongling Miao, Zhao Wu, Hanbing Yan. Factors affecting online learning viscosity from the perspective of leris's (2007) theory [J]. *Distance education in China (Comprehensive Edition)*, 2021:68-75

- Hehai Liu, Shuyu Zhang, Lilan Zhu. Discussion of Essence, Connotation and Value of MOOCs [J]. Modern educational technology, 2014:5-11
- Jiayi Zhu. Education reform triggered by big data: a ripple or a huge wave? [J]. Theory and Reform, 2016:118-123
- Jinjie Xu. Responses to COVID-19 and Challenges to Large-scale Online Learning for Global Education System: Findings and Insights Based on Results from OECD Survey across Nations [J]. Journal of Distance Education, 2020: 3-10
- Nanxing Zhang. The Status Quo and Further Development Strategy of China's Online Higher Education in the Perspective of International Comparison [J]. Chinese Higher Education Research, 2021:48-55
- Ronghuai Huang. Research on the Core Elements of Running a Huge Scale of Cyber-learning: A Case Study of "Disrupted Class, Undisrupted Learning" Supported Effectively by Online Education [J]. E-education Research, 2020:10-19
- Shu Liu. Research on Online Learning Platform Experience from the Perspective of Users [J]. E-education Research, 2019:47-52
- Shuaiguo Wang. Rain Classroom: The Wisdom Teaching Tool in the Context of Mobile Internet and Big Data [J]. Modern educational technology, 2017: 26-32
- Xiao Wang, Zhiquan Wang. Research on the Teaching Mode of Chinese Universities in the Context of MOOC [J]. Journal of National Academy of Education Administration, 2015:41-45

