

# *Development Trends and Frontiers of Audio-visual Education Research Based on CiteSpace*

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**Keywords:** Audio-visual education, CiteSpace, Artificial intelligence, Flipped classroom

**Abstract:** Based on 4883 articles published in two CSSCI journals in the field of electronic education in the past ten years, this paper used CiteSpace to analyze the knowledge graph of this field. Through author co-occurrence analysis co-citation analysis, keyword clustering and time zone map, the research status and hotspots in the field of audio-visual education are analyzed. The results show that the cooperative relationship between authors in the field of audio-visual education is not close enough. In terms of keyword emergence words and cluster analysis, the research hotspots of education mainly focus on flipped classroom, artificial intelligence, network learning resources another fields. It can be seen that in the context of the Internet era, this field has very broad prospects for development.

## 1. Introduction

“Audio-visual education” has been introduced into our country since the 1920s. In the past few decades, it has experienced the initial stage, development stage and in-depth development stage [1]. As a novel form of teaching, audio-visual education mainly realizes the dissemination of knowledge through computer technology, audio-visual materials, etc. which plays an important role in improving the quality of teaching [2].

As the social law of the future requires all-round development, the reform of the traditional education has become an urgent matter. However, the traditional classroom education can not meet the social development, modern educational technology has become the impetus of educational reform. The transition from audio-visual education to modern education technology is the requirement of the history. Based on this, this paper uses CiteSpace software to analyze the research results in the field of audio-visual education visually, to observe the academic research in this field, and to reveal and reflect the problems in the development of audio-visual education, reveal the research hotspots and research frontiers of audio-visual education, and provide new solutions for the development of audio-visual education.

## 2. Data Sources and Methods

### 2.1 Research Methods

This paper uses CiteSpace developed by Professor Chen Chaomei, which is widely used and has become a new generation of information visualization analysis tool. Through co-occurrence analysis, co-citation analysis and cluster analysis, the status quo, hot spots and trends in the research field are reflected [3].

### 2.2 Data Sources

This paper takes the literature published by two well-known CSSCI journals in the field of audio-visual education, “China Audio-visual Education” and “Audio-visual Education Research”, as the research object, with the time range from 2011 to 2020. After data sorting, a total of research literature is obtained.

## 3. Structural Characteristics of Audio-Visual Education Research

### 3.1. Author Co-occurrence Analysis

The node is set as “Author”, and the knowledge graph of Author co-occurrence analysis in the field of electronic education research is shown in Figure 1. The node and font size represent the cited times and cited number of the Author respectively. A total of 437 nodes and 458 lines were obtained, and the map density was 0.0048.

It can be seen from Figure 1 that the distribution of authors is relatively scattered, indicating that researchers in the field of electronic education from 2011 to 2022 do not cooperate closely, and mainly work in small teams.

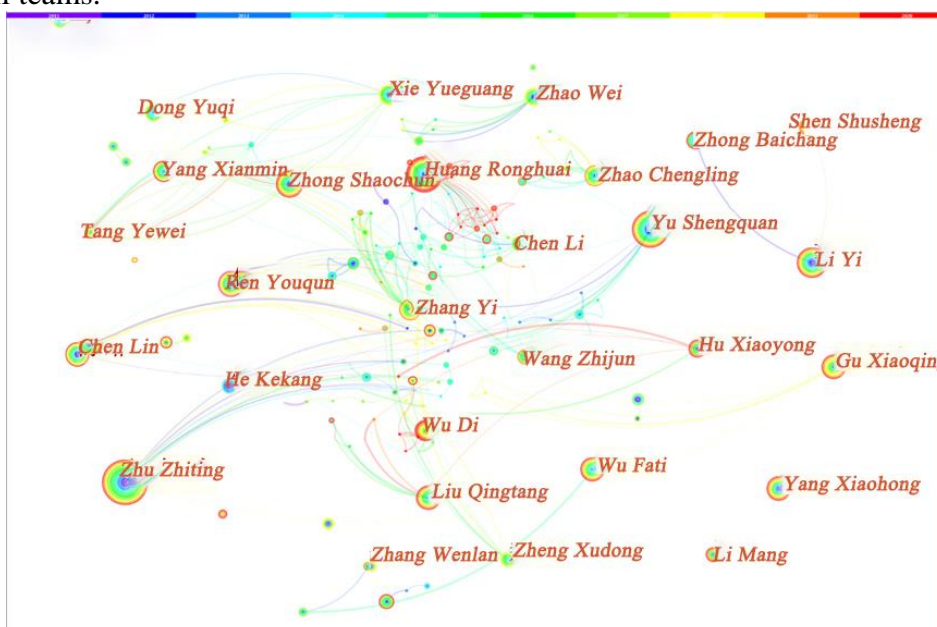


Figure 1: Co-authorship network of core authors

### 3.2. Journal Citation Analysis

The document data was imported into CiteSpace and the node was set as Cited Journal to obtain

the Journal co-cited knowledge map, as shown in Figure 2. There were 899 nodes and 3445 links in the map, and the map density was 0.0085. The node size and font size represented the number of cited times and citations, respectively.

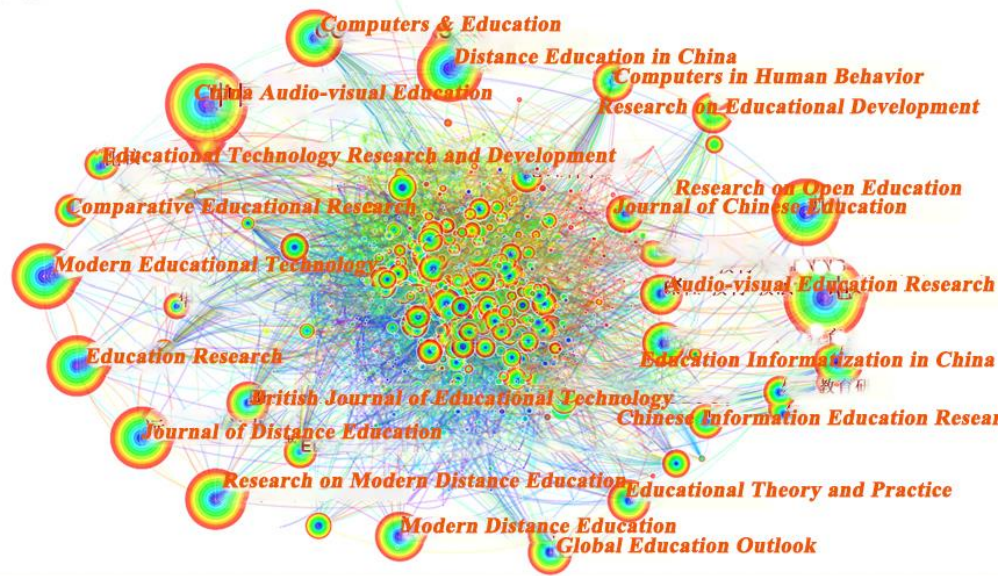


Figure 2: Knowledge map of cited journals

Among them, 11 journals were cited more than 100 times, as shown in Table 1. Cited journals are the top journals with important academic influence at home and abroad, reflecting the authoritativeness of the knowledge base of electronic education research. Among them, there is one foreign language periodical, *Computers & Education*, and 10 Chinese periodicals, including *China Audio-visual Education*, *Audio-visual Education Research*, *Open Education Research*, *Modern Educational Technology*, *Education Research*, etc. It shows that although domestic research on audio-visual education will be based on foreign research, domestic research on audio-visual education has formed a distinctive research direction in the local context. These journals are important sources of journals in the field of audio-visual education.

Table 1: Frequency of top 11 cited journals

Rank	Frequency	Year	Source
1	2816	2011	China Audio-visual Education
2	2473	2011	Audio-visual Education Research
3	1181	2011	Modern Educational Technology
4	1138	2011	Open Education Research
5	916	2011	Journal of Distance
6	781	2011	Education Research
7	742	2011	Research on Modern Distance Education
8	709	2011	Distance Education in China
9	474	2011	Computers & Education
10	342	2011	Education Informatization in China
11	329	2011	Modern Distance Education

### 3.3. Author Co-citation Analysis

In order to identify Cited authors with a high frequency, Node Type is set to Cited Author, reference

value is set to T50, and the rest is set to default. The Author Cited knowledge map is obtained, which has 904 nodes and 2614 links in total. See Figure 3.

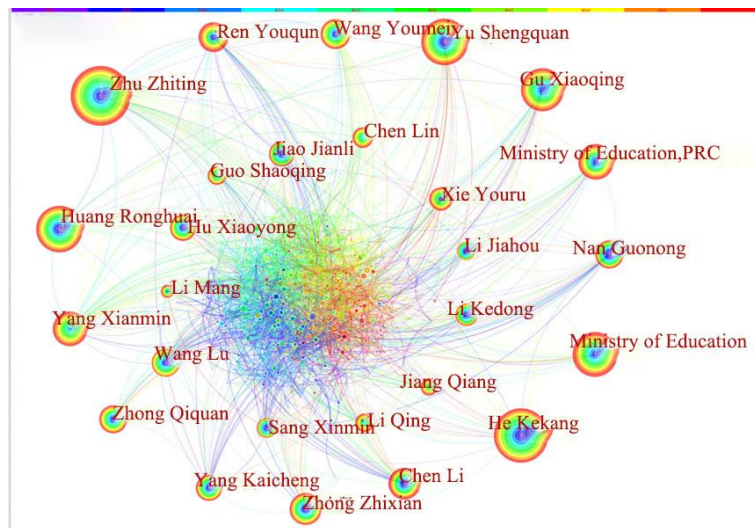


Figure 3: Author co-cited knowledge map from 2011 to 2020

Detailed information of highly cited authors in the field of audio-visual education in the last decade is shown in Table 2. It can be found that from 2011 to 2020, domestic scholars who have exerted an important influence on the research of audio-visual education include Zhu Zhiting, Li Yi, Huang Ronghuai, Yu Shengquan, etc. These authors play a great role in promoting the research of audio-visual education. As can be seen from the Figure 3, the author of the cited frequency is highest is Zhu Zhiting, cited frequency is 576 times, Zhu Zhiting is an important researcher in the field of audio-visual education, from 2011 to 2014, were cited 112 times, 128 times, 128 times, 131 times, you can see in this a few years electrochemical heat or higher education research, during a sudden point is in in 2017, it reached 148. Followed by Huang Ronghuai, Yu Shengquan, He Kekang, Gu Xiaoqing, cited more than 200 times, these scholars have a great impact on the development of electronic education.

Table 2: Highly cited authors (top 10)

Ranking	Frequency	Centrality	The author	Year
1	576	0.08	Zhu Zhiting	2011
2	491	0.11	He Kekang	2011
3	375	0.05	Yu Shengquan	2011
4	354	0.09	Education Part	2011
5	308	0.12	Huang Ronghuai	2011
6	259	0.08	Yang Xianmin	2012
7	234	0.12	Gu Xiaoqing	2011
8	211	0.09	Huang Guonong	2011
9	158	0.04	Chen Li	2011
10	153	0.02	Zhong Zhixian	2011

### 3.4. Literature Co-citation Analysis

In CiteSpace, set the node type to "Reference "and obtain the knowledge graph of the reference within a period of one year, as shown in Figure 4. A total of 707 nodes and 2518 lines were obtained

from the map, and the map was dense Degree of 0.0101. The larger the nodes in the figure, the more frequent the references appear, that is, the more times they are cited. As can be seen from the figure, Zhu Zhiting[4], Yang Xianmin[5], Yu Xiaohua and Zhu Zhiting[6],Zhu Zhiting[7],are cited more frequently.

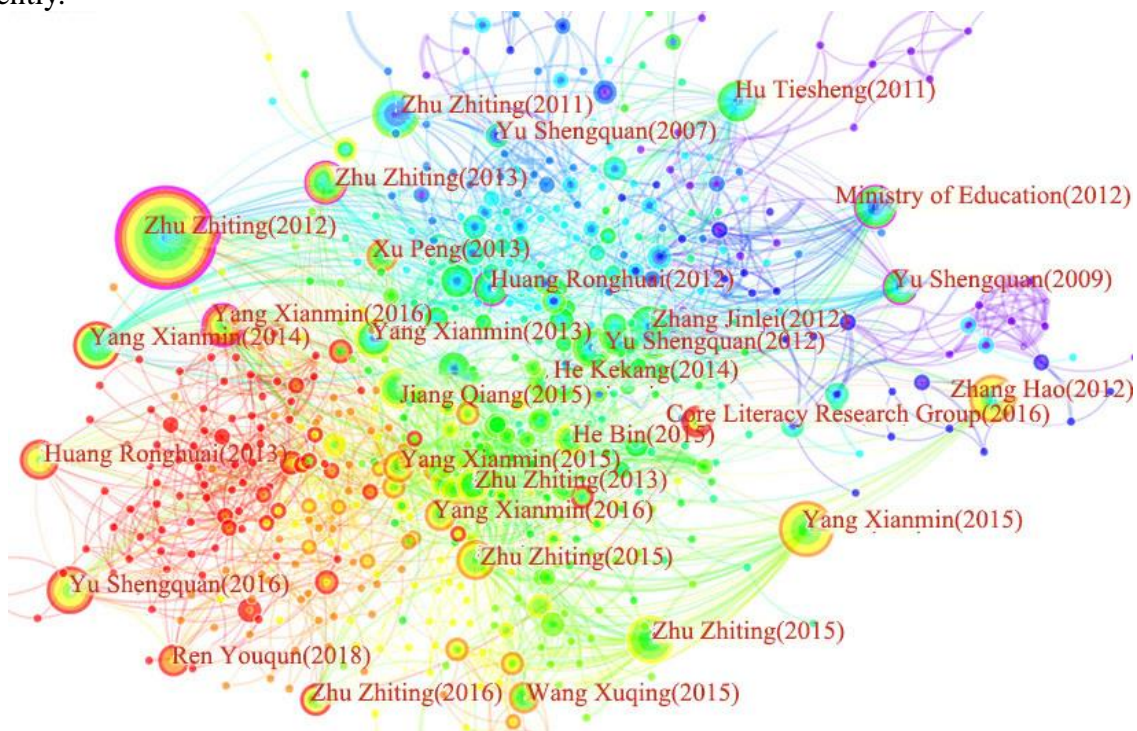


Figure 4: Knowledge map of reference literature

In order to further understand the information of key node literature, this paper lists the top ten references with high citation frequency, as shown in Table 3. First, some scholars studied the development path of educational informatization and explored the new technology of educational innovation development. Cited frequency of most of these articles is Zhu Zhiting [4], he pointed out that wisdom education is the education development in the article reached a new level, today's education informatization development, has brought significant changes of education forms and ways of learning, in particular, has been clear about the difference between wisdom and intelligence education, emphasizes the education informatization need wisdom and innovation. Secondly, Yang Xianmin [5] proposed that ubiquitous learning needs to adopt the open and collaborative construction mode of "group building and sharing" to realize the generation and change of ubiquitous learning resources. To find all kinds of learning resources, through the open network structure, allow many users to edit the content, enrich the content, simplify the structure and achieve the purpose of resource evolution. Then Zhu Zhiting [7] thought the changes in the informatization technology will promote the development of primary and middle school information technology courses, information technology affects the adolescents, life and study aspects, finally proposed to focus on students "design thinking", "critical thinking", the development of the "computing thinking", set up operational learning goals, to grasp the information under the premise of knowledge and skills, guides the student to comprehensive recognition Understand this information society.

From Table 3 and Figure 4, the top 10 key nodes in the literature post time is one of the earliest Yu Xiaohua and Zhu Zhiting [7], his literature centered classroom "flip", "action research", on the basis of modern education technology and related technology, explore electrochemical education development model and development prospects, puts forward the future and effectiveness of the classroom to achieve high availability, class to interact frequently, The correct orientation of each

discipline is determined, resources can be shared, and every student can make full use of teaching resources as far as possible, which builds a theoretical framework for subsequent research. Through literature analysis of key nodes, it can be found that literatures with high citation and high centrality are mainly distributed in the period of stable wine blending and the period of rapid development, as shown in Figure 1. As the key literature in the field of audio-visual education, it lays a theoretical foundation for the subsequent accumulation of literature in this field and the change of research hotspots. By analyzing the research content of node literature, it is found that the early literature mainly focuses on the theoretical research of audio-visual education. With the further development of audio-visual education research, under the correct guidance of national education policy, a combination of theoretical research and practical problems related research.

Table 3: Important references of domestic research on audio-visual education

Rank	frequency	Authors	Year	Title	centrality
1	73	Zhu Zhiting	2012	Wisdom education: a new realm of educational informationization	0.28
2	31	Yang Xianmin	2015	A study on ordered evolution of learning resources in ubiquitous learning environment	0.04
3	30	Yu Xiaohua	2011	A new boost to interaction support in CSCL-multi-touch technology	0.03
4	30	Zhu Zhiting	2015	Maker education: The practice field of innovative education enabled by information technology	0.01
5	29	Wu Pengfei	2016	Study the research and practice of semantic	0.05
6	26	Yang Xianmin	2016	Buliding maker Curriculum:The connotation, characteristics and design framework of "maker"	0.1
7	26	Zhu Zhiting	2015	Subject-oriented information technology curriculum design: A case study of high school information technology curriculum	0.01
8	25	Chen Xionghui	2012	Education informationization: The possibility of people's all-round development	0.13
9	25	Zhuang Rongxia	2017	Analysis on the development characteristics of urban typical field learning environment	0.09
10	24	He Kekang	2014	See the future development of flipped classroom in China from the essence of flipped classroom	0.03

In order to further analyze the law of cited literatures, literatures were clustered, as shown in Figure 5. There are 705 nodes, 2417 lines and 12 clusters in the figure. Small clusters are removed and LLR algorithm is adopted to obtain 8 clusters, which are "artificial intelligence", "Learning Resources", "flipped classroom", "Network learning space", "Smart Age", "Maker education", "high availability" and "Community of Practice".

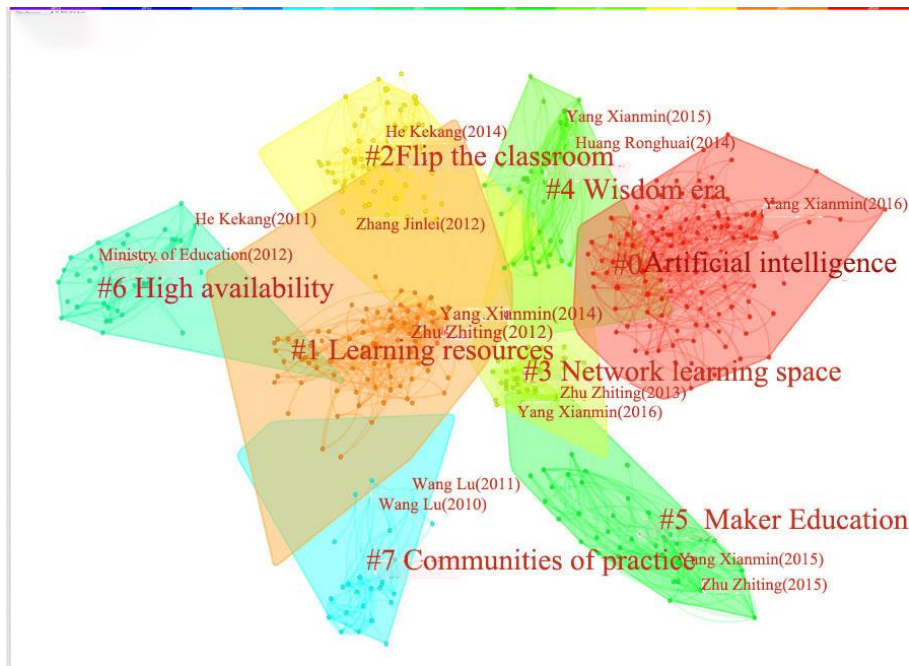


Figure 5: Literature clustering in the field of audio-visual education

The clustering details are shown in Table 4. The contour value can reflect the quality of clustering evaluation, and the Silhouettes of each cluster is between 0.659 and 0.973, indicating that clustering is very reasonable. From Table 4, we can also see the labels of the first 8 digits of the cluster from which we can see the direction and emphasis explored by the problems of audio-visual education.

Table 4: Literature clustering information in the field of audio-visual education

Cluster	Frequency	Silhouettes	Year	Label
0	132	0.889	2017	Artificial Intelligence
1	91	0.792	2012	Learning Resources
2	73	0.827	2013	Flip the Classroom
3	47	0.855	2014	Network Learning Space
4	46	0.895	2015	Wisdom Era
5	42	0.959	2015	Aguest to Teach
6	38	0.926	2010	High Availability
7	34	0.935	2009	Communities of Practice

Further, using Jiang and Qu's method [8], we analyzed in detail the top five literatures with the highest citation in the first three clusters.

Table 5: Highly cited literatures of "Artificial intelligence" in cluster 0(Top five)

rank	Frequency	Centralit y	Author	Year	Journal
1	29	0.06	ShengQuan Yu	2016	China Audio-visual Education
2	26	0.13	XianMin Yang	2016	Research on modern distance education
3	25	0.09	RongHuai Huang	2017	China Audio-visual Education
4	19	0.08	Core Literacy Research Group	2016	Journal of Chinese Education
5	17	0.04	YouQun Ren	2018	China Audio-visual Education

Table 5 shows cluster 0. “Artificial intelligence”, which is the largest cluster, containing 132 literatures. This cluster mainly studies the application of audio-visual education in artificial intelligence industry. Yu Shengquan [9] is cited with the highest frequency in this cluster. Artificial intelligence technology is used to develop classroom courses and create value-added concept imitation learning models. In addition, artificial intelligence can also be applied in flipped classroom, online teaching and other aspects. During the COVID-19 pandemic, social experiments have been carried out to realize human-computer intelligent collaboration and achieve informatization and comprehensive education. Yang Xianmin [10] has made a detailed analysis of the connotation, characteristics and design framework of “maker”, which plays a huge role in promoting the search of audio-visual education.

Table6: Cluster1“Learning resources” highly cited literature(Top five)

Rank	Frequency	Centrality	Author	Year	Journal
1	55	0.23	Zhu Zhiting	2012	Audio-visual education research
2	21	0.08	Yang Xianmin	2014	China Audio-visual Education
3	20	0.1	Huang Ronghuai	2012	Research on open Education
4	18	0.03	Yang Xianmin	2013	Education research
5	16	0.07	Zhu Zhiting	2013	Audio-visual education research

Cluster 1 in Table 6 is a learning resource, which contains 91 papers and is related to educational resources needed for the future development of audio-visual education. Zhu Zhiting was cited 55times, mainly around the “Internet +” education, “rural education”, “influencing factors” and other keywords, using real-time data, research progress, theory, to carry out a systematic and sufficient study of electronic education. After that, many researchers started from different perspectives, adopted diversified research methods, and selected different research directions for different research fields to carry out localized research on audio-visual education.

Table 7: Cluster2“flipped classroom” with high citation(Top five)

Rank	Frequency	Centrality	Author	Year	Journal
1	24	0.04	Kekang He	2014	Audio-visual education research
2	24	0.03	Jinlei Zhang	2012	Journal of Distance Education
3	21	0.06	Tiesheng Hu	2011	Audio-visual education research
4	20	0.06	Bin He	2015	China Audio-visual Education
5	18	0.02	Shengquan Yu	2012	China Audio-visual Education

Cluster 2 in Table 7 is flipped classroom, which contains 73 literatures. Flipped classroom means that students watch teachers' video explanation before or after class and study independently. Teachers no longer occupy class time to teach knowledge, and classroom becomes a place for interaction between teachers and students and between students. The popularization of Internet and the application of computer technology in the field of education make the “flipped classroom” teaching model feasible and realistic. Students can use high-quality educational resources through the Internet. and teachers have more responsibility to understand students' problems and guide students to use knowledge [11]. Zhang Jinlei [12] analyzed in detail the future development mode of e-education mainly around “e-schoolbag”, “flipped classroom” and “teaching mode”.



## 4. Research Hotspots and Path Evolution

### 4.1. Analysis of Research Hotspots

A research hotspot refers to a group of related topics studied by a certain number of literatures in a certain period of time. By analyzing the hot spots of keyword co-occurrence atlas, we can observe the evolution trend of the research in the field of audio-visual education and accurately extract the hot spots in the field of audio-visual education. Keywords are the concise summary and description of the literature content. By analyzing the co-occurrence of keywords in the field of audio-visual education, the hot research trends in this field can be summarized. In this paper, keywords co-occurrence analysis was carried out by CiteSpace software, and the network atlas in Figure 6 was obtained. The map contained 251 nodes, 1166 lines, and a density of 0.0372.

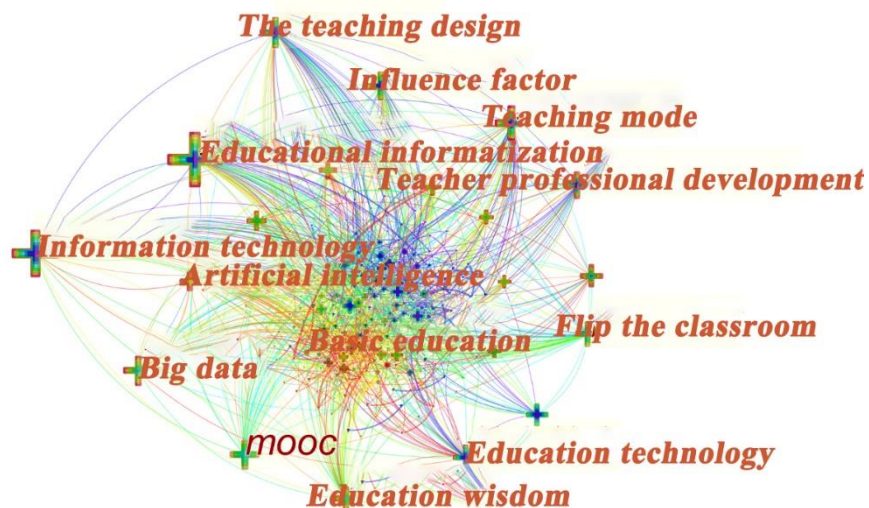


Figure 6: Co-occurrence knowledge map of key words

The keywords that appeared more than 100 times were educational informatization (241times), information technology (157 times), MOOC (117 times), educational technology (111 times), instructional design (105 times) and big data (104 times). It can be seen from FIG. 6 that the network structure of keywords co-occurrence is relatively close, indicating that the corresponding keywords are popular in research.

The development of audio-visual education in China has different characteristics in different periods. In order to reflect the research hotspots in different periods, this paper analyzes the development of audio-visual education through key words. Figure 7 shows 25 key words, which can help us understand the concepts and potential problems highlighted in the process of studying the development of audio-visual education, so as to further understand the frontier of the research field of audio-visual education.

As can be seen from Figure 7, “distance education”, “online course”, “network environment”, “network”, “teaching resources”, “countermeasures”, “strategies” in 2012 and “electronic schoolbag” in 2013 were the keywords with high mutation degree from the first few years, and then the research popularity gradually decreased to a stable level. MOOC (2014-2016), flipped classroom (2014-2016), micro class (2014-2016), MOOC (2015-2017), maker education (2016-2018) and smart education (2016-2018) is a declining mutation, which gradually decreases to a stable level after 2-3 years of

popularity. Learning Analytics (2016-2020), Online Learning Space (2016-2020), Big Data in Education (2016-2020), Internet +(2017-2020), Big Data (2017-2020), Deep Learning (2017-2020), STEM education (2017-2020), Core Literacy (2017-2020), artificial intelligence (2018-2020), educational informatization (2018-2020), intelligent classroom (2018-2020) research attention is a rising mutation, the attention gradually increased, is still a hot issue.

### Top 25 Keywords with the Strongest Citation Bursts



Figure 7: Key words in audio-visual education

### 4.2. Path Evolution Analysis

In order to better display the Time distribution and evolution trend of research topics related to audio-visual education, this paper obtained the path evolution map of audio-visual education research by drawing the Time Zone view. After decades of development and research, the research content of audio-visual education has been continuously expanded and enriched, as shown in Figure 8. The nodes in the same time period are set in the time region of the system, arranged in order from far to near, and the keywords in each period are closely connected, which can more intuitively explore the development vein of electronic education in recent years.

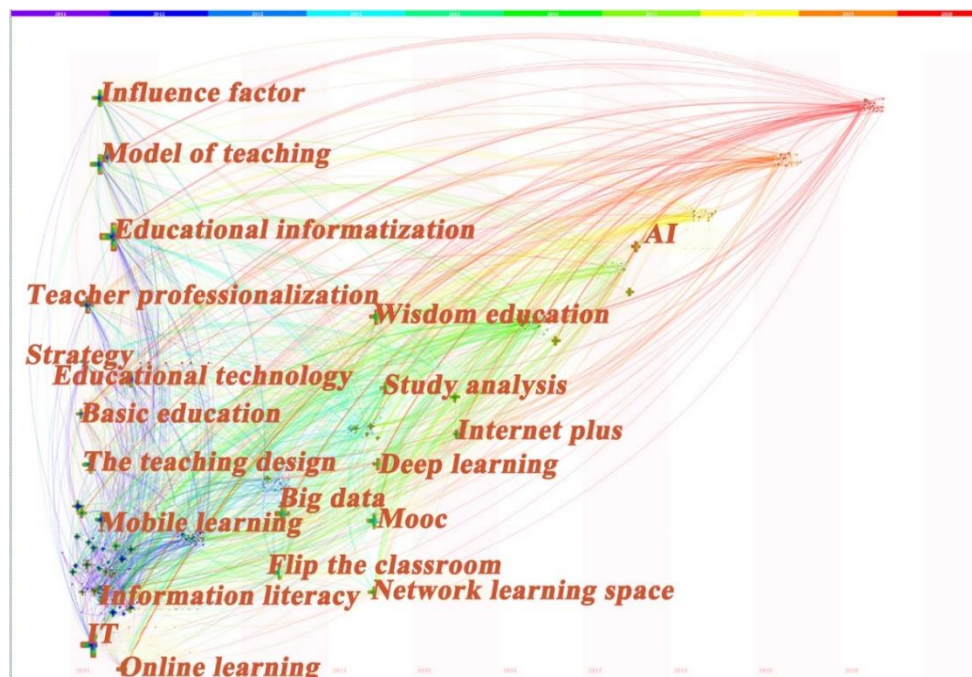


Figure 8: Time zone map of keywords

As can be seen from Figure 8, the year 2011 is the breakout period of research in the field of audio-visual education. Before this, there may be a series of studies to pave the way, and many research hotspots have emerged in the follow-up, such as educational informatization, influencing factors, teaching mode, teacher professional development, information technology, etc. With the development of science and technology, more and more attention to education information resources development and utilization, and want to improve information literacy into the education goal, cultivating talents, to adapt to the information society after researchers through learning and innovation was proposed in 2013 by reverse classroom teaching mode, combined with large data such as technology, makes the teachers can make full use of teaching time in class. Since 2013, there have been new research directions in the field of audio-visual education, including “smart education”, “learning analysis”, “MOOC” and “network learning space”. Later, researchers combined audio-visual education with the development of the times and made more in-depth studies on audio-visual education by using artificial intelligence.

## 5. Conclusion and Future Research

### 5.1. Conclusions

Based on 4883 articles published in two CSSCI journals in the field of audio-visual education in the past ten years, this paper uses CiteSpace to conduct knowledge map analysis in this field. Through author co-occurrence analysis, co-citation analysis, keyword clustering, time zone map and so on, this paper analyzes the research status, research hotspots and path evolution in the field of audio-visual education.

First, from the perspective of the authors' cooperative network, the cooperative relationship between the authors is not close enough, which is dominated by “academic relationship” and fails to truly form a cooperative relationship with the research project as the core driving force.

Second, through keyword emergence words and cluster analysis, the research hotspots of education mainly focus on flipped classroom, artificial intelligence, network learning resources and other fields.

Third, time zone based on keywords and keyword dash forward show figure, analysis on the research focus in the audio-visual education, front, this paper found that the research on audio-visual education has experienced different stages of development, from the initial analysis of affecting factors, to the big data and the combination of the Internet, and then the fusion such as artificial intelligence, it can be seen in the context of the Internet age has very broad prospects for development in this field.

## 5.2. Future Research

With the progress of technology and the development of the education concept, reflects the characteristics of higher starting point, more choice, broader research in the field of vision and brought new challenge to education of all types and at all levels, the researchers to new technology, new ideas of research attention, for the latest information technology and its application in the education teaching become a significant development trend. However, the research on audio-visual education is not enough to meet the rapid development of network information needs. Therefore, we need to strengthen the oriented research on various labels, explore the evaluation mechanism suitable for regional education, realize resource sharing, meet the needs of various groups, and show the broad prospects of audio-visual education.

## Acknowledgements

This work is supported by Quality Engineering project of Higher Education in Anhui Province(Grant No.2020xsxxkc399)

## References

- [1] Cao Mei, Zhang Zhengrong, Zhang Shuyu. *The Development process of Educational Technology organization in China. Research on Audio-visual Education*, 2010(12):106-110.
- [2] Zhang Zhiyang on the role of audio-visual education in moral education under new media. *Basic Education Forum*20219):107-109.
- [3] Li Jie, Chen Chaomei. *Text mining and visualization of Citespace technology. Capital University of Economics and Business Press*, 2016.
- [4] Zhu Ziting, He Bin, *Wisdom Education: A New Realm of Educational Ifomatization. Research on audio-visual education*2012, 312):5-13.
- [5] Yang xianmin. *Research on oderlevolution of learning resources in ubiquitous learning environment. Research of. adio-visual education*. 2015, 601:62-68.
- [6] Yu Xiaohua, Zhu Zhiting. *A new boost to interaction support in CSCL- muti-touch technology. Research on Audio-visual Education*, 2011(01):64-68.
- [7] Zhu Zhiting, Li Feng. *Subject thinking oriented information technology curriculum design: a case study of high school information technology crriculum, electronic education research*, 2015, 36(01):83-88.
- [8] Jiang, J., Qu, L. *Evolution and Emerging Trends of Sustainability in Manufacturing (1999–2019) Based on Literature Visualization Analysis. IEEE Access*, 2020, 8(99):121074-121088.
- [9] Yu Shengquan, A xi Wang *The transformation Path for “Internet + Education”. Research on Audio-visual education in China*. 2016(10):1-9.
- [10] Yang Xianmin. *The Construction of Maker Course: Connotation, Characteristics and the Design of “Maker Course” Framework. Journal of Distance Education*. 2016, 35(03):3-14.
- [11] He Kekang. *From the essence of “flipped classroom”, see the future development of “flipped classroom” in China. Audio-visual education research*, 2014, 35(07):5-16.
- [12] Zhang Jinlei, Wang Yin, Bao Huizhang, *Research on flipped Classroom Teaching model. Journal of Distance Education*. 2012, 30(04):46-51.