

A CiteSpace Analysis of Research on MOOCs

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Abstract. Under the background of online education, MOOCs have welcomed the widespread attention all over the world. The present study analyzes the literacy and keywords of the published articles during the 10-year period (2009-2018) from the database of Web of Science by employing the visualization software of CiteSpace V to explore the development and research hot issues of MOOCs. The increasing annual publications of MOOCs during this period show researchers' growing interest and the important role MOOCs have been playing in various fields. The co-citation network of the literature on MOOCs suggest the most frequently cited references which are fundamental in the rise and development of MOOCs. The network of co-occurring keywords facilitates the interpretation of the topics and the research hotspots are presented as follows: the influence of MOOCs on higher education, the introduction and review on MOOCs, the supporting technologies of MOOCs, learning activities and learners' features, the study on blended learning based on MOOCs and the background knowledge about the birth of MOOCs. The present analysis is expected to provide some clues for the future development of MOOCs.

1. Introduction

The fast development of information technology and its wide application in people's life has caused the huge change in educational idea and learning modes. Quality education, personalized learning and lifelong learning have become the new trends in recent years, and the rise of MOOCs meets the needs of education in this new era. The concept of MOOCs (Massive Open Online Courses) was firstly put forward by Dave Cormier and Bryan Alexander in the year of 2008. These keywords in "MOOCs" suggest their main features. "Massive" refers to the large quantity of learners in these courses, "online" means that the teaching and learning process is carried out in the internet with the flexibility of time and space, and "open" conveys the educational concept that learners can learn the quality courses if they can get access to the internet. As the fundamental characteristic of MOOCs, "openness" is interpreted as "When learners step through our open door, they are invited to enter our place of work, to join the research, to join the discussion, and to contribute in the growth of knowledge within a certain field." [1] That is to say, "any individual with an Internet connection can join a MOOC, to access the available resources, interact with other students, reflect and share what they have learned with others" [2,3].

In the field of higher education, MOOCs have achieved wide attention from researchers and educational institutions and have become an important issue in online education. Recent years, the achievements of studies on MOOCs are increasingly fruitful. Scholars and academic institutions have carried out researches on MOOCs from various angles and perspectives, which mainly cover the introduction and review on MOOCs, the relationship between MOOCs and teaching reforms in higher education, the supporting technologies and running modes of MOOCs, and the application and spreading of MOOCs. It is safe to say that MOOCs have become the valuable innovation in the field of online education, which has brought the unprecedented influences on and challenges for traditional education involving the aspects of teaching idea, teaching system, teaching technology, teaching

industry, teaching modes and so on and so forth. In the future, studies on these aspects are to improve the advancement and development of MOOCs and the reform of the whole educational system.

The present paper teases out the relevant literature of MOOCs presented in the data corpora of Web of Science to show the mapping knowledge domains of MOOCs, review the distribution features of MOOCs' research and provide suggestions for the future research in order to know about the development of MOOCs and enhance its application. The structure of this paper is organized as follows: Section 2 presents the research design. Section 3 shows the results and discussion. Finally, Section 4 concludes the paper and points out further work.

2. Research design

2.1 The source of data

The data corpora of Web of Science developed by Thomson Reuters is used as the source of data in this research. Web of Science Core Collection is selected as the database to ensure the high quality of the presented literature and the topics are set as "MOOCs" OR "MOOC" OR "Massive Open Online Courses". The timespan is set as a ten-year period from 2009 to 2018 and the document type is article, excluding the proceedings papers, editorial material, book reviews and reviews. The reason why the timespan starts from the year of 2009 is that the first published paper on MOOCs in the field of education was written by the Italian scholar Fini Antonio in 2009 [4]. The search results in this study including full records and references are downloaded and handled by CiteSpace.

2.2 Research tool

The research tool used in this study is the visualization analysis software CiteSpace 5.3.R4 developed by Doctor Chaomei Chen and his team. CiteSpace covers various functions to help researchers understand the network patterns of a certain field, such as how it grows from a new topic to the present, what are the citation hotspots in the publications, and how the international institutions are collaborated [5]. It also provides the networks of node types including author, institution, country, term, keyword, source, category, reference, cited author, cited journal, etc.. The Web of Science is the major source of input data for CiteSpace. This powerful analysis function of this software makes it an influential visualization tool to present a vivid image of the key literature, research hotspots and the frontiers in a certain scientific field.

2.3 Research procedures

The present study is going to be carried out based on the following steps:

(1) The annual publications of MOOCs and the top 10 research fields concerning MOOCs between the period of 2009 and 2018 will be presented to show the general trends and features of MOOCs.

(2) The co-citation analysis will be carried out to suggest how the frequently cited references have influenced the development of MOOCs.

(3) The visualization analysis of research hotspots in MOOCs will be got from the network of co-occurring keywords and the most concerned issues will be discussed.

2.4 Research methods

MOOCs are a complex subject and the studies cover various aspects such as education, technology, business, internalization, etc., which require different research methods to ensure the full interpretation. The two methods employed in this study are as follows:

(1) Literature research method. Literature research aims to collect, distinguish, compare and integrate the relevant literature to extract the useful information, recognize the nature of research questions, and explore the inner relationship and development trend of research objects. This paper searches and analyzes the literature on MOOCs from the Web of Science and discusses the meaning of MOOCs, their features and general development.

(2) Knowledge mapping analysis. This kind of analysis is a recently emerging research method in the field of scientometrics and bibliometrics on the basis of citation analysis theory and information science and technology, and presents the research frontiers vividly by means of visualization image, which shows the disciplinary structure and development trend. This quantitative analysis assesses the scientific activities and makes the research process relatively objective and convenient. This paper employs the research method of scientometrics and the software of CiteSpace to study the literature from the data corpora of Web of Science and get the knowledge mapping about the network of citation and keywords, which provide the clues for the research fronts and research hotspots of MOOCs.

3. Results and discussion

3.1 General trends and features

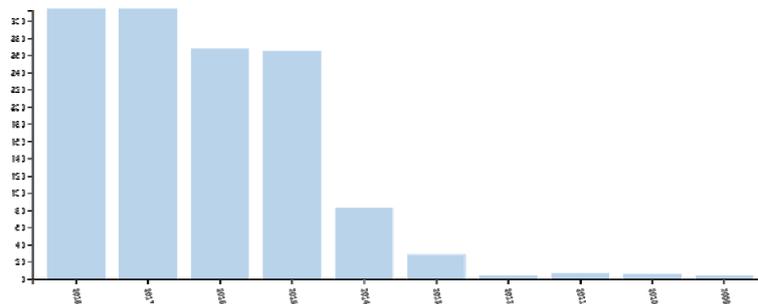


Fig. 1. Annual Publications in the field of MOOCs

The above figure presents the annual publications on the topic of MOOCs since the year of 2009 and shows that MOOCs have received high popularity and relative literature has increased a lot since the year of 2013. In the article published in New York Times by Pappano, the year of 2012 was called “the year of MOOC” [6]. Studies on MOOCs has received wide attention since 2012 and many famous universities in the USA launched MOOCs in higher education. In January of 2012, over 1,700,000 students enrolled the courses. In the autumn of the same year, over 370,000 students became learners on the platform of edX, which was built by the University of Harvard and MIT. In September of 2012, Google launched the online tool of MOOCs. These initiatives have greatly improved the development of MOOCs. The annual amount of articles is about 30 in 2013 and reaches 80 in 2014. In the recent two years, this amount has reached the peak of over 300 a year. The continuing increase of the publications on MOOCs shows the important role MOOCs have been playing in recent years. Further exploration suggests that the high quality universities, open universities, education and research institutions, and MOOCs institutions stimulate the rise and development of MOOCs. The academic journals have become the platforms for the discussion and transmission of the fruits of MOOCs’ study. Besides, MOOCs’ flourishing development happens in the new era of the popularity and openness of higher education in advanced countries, when education and knowledge are increasingly presenting the tendency of commercialization. Meanwhile, with the increase of the demand for education, the cost for running the educational institution is rising and the educational quality is decreasing. Under the above-mentioned background, MOOCs’ rise conforms to the development tendency of higher education, meets the idea of resources sharing and educational fairness, mitigates the contradiction between the running cost and the teaching quality to a certain extent, all of which offer the easily accessed platform of obtaining knowledge for the learners who are eager for higher education.

The top ranked fields concerning MOOCs are shown in Table 1. These research fields can be further divided into four different categories: educational research, information and computer science, engineering, and communication and management.

Table 1. The top fields concerning MOOCs

Select	Field: Web of Science Categories	Record Count	% of 1,273	Bar Chart
<input type="checkbox"/>	EDUCATION EDUCATIONAL RESEARCH	753	59.152 %	<div style="width: 59.152%;"></div>
<input type="checkbox"/>	COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS	89	6.991 %	<div style="width: 6.991%;"></div>
<input type="checkbox"/>	EDUCATION SCIENTIFIC DISCIPLINES	51	4.006 %	<div style="width: 4.006%;"></div>
<input type="checkbox"/>	COMPUTER SCIENCE THEORY METHODS	40	3.142 %	<div style="width: 3.142%;"></div>
<input type="checkbox"/>	COMPUTER SCIENCE INFORMATION SYSTEMS	39	3.064 %	<div style="width: 3.064%;"></div>
<input type="checkbox"/>	INFORMATION SCIENCE LIBRARY SCIENCE	39	3.064 %	<div style="width: 3.064%;"></div>
<input type="checkbox"/>	ENGINEERING MULTIDISCIPLINARY	38	2.985 %	<div style="width: 2.985%;"></div>
<input type="checkbox"/>	COMPUTER SCIENCE SOFTWARE ENGINEERING	37	2.907 %	<div style="width: 2.907%;"></div>
<input type="checkbox"/>	COMMUNICATION	33	2.592 %	<div style="width: 2.592%;"></div>
<input type="checkbox"/>	MANAGEMENT	29	2.278 %	<div style="width: 2.278%;"></div>

The distribution of these publications in different research fields shows that studies on MOOCs are mainly in the field of educational research. Its distribution in other fields suggests that the study on MOOCs has been interdisciplinary and involved various fields.

3.2 The document co-citation network of MOOCs

The co-citation analysis presents the relationship between the literature by means of the frequency cited by other literature. The higher rate of the cited frequency, the closer relationship between the two pieces of literature, i.e. they share more similarities of disciplinary background. This kind of analysis facilitates the understanding and interpretation of the structure, kinship and evolution rules of a certain discipline. The co-citation network of the literature on MOOCs in the past 10 years is shown in figure 2. The purple circle represents the key node, and the bigger the node, the higher rate of citation. The frequently cited literature often plays a fundamental role in the building of a certain research field.

The knowledge mapping of the co-citation analysis is able to vividly suggest the knowledge background of a research field. When two articles are co-cited by the articles in the future, they have the co-cited relationship and often share the similar research object, research method or theory. The co-cited literature represents the status quo in the research field, the analysis of which can facilitate the understanding of the development line and the research background of a certain field, and the interpretation of the research frontiers. On the platform of CiteSpace, the “node types” is set as “Reference” and the cited references map of MOOCs is presented in Fig. 2. Different nodes stand for different literature, the size of the nodes suggests the cited frequency of the literature, and the nodes with the purple circle are considered as the key nodes.

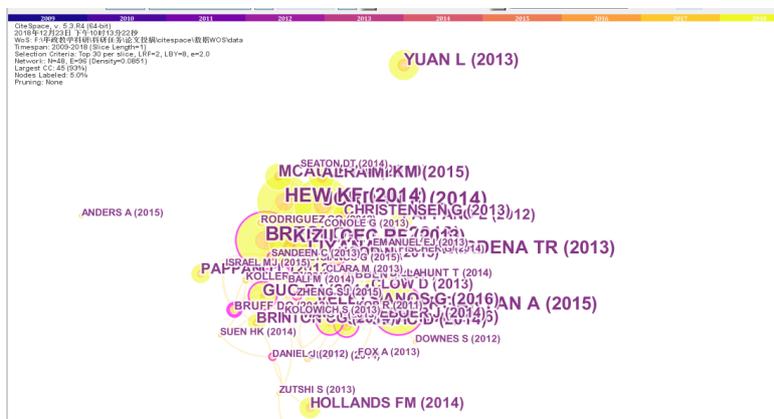


Fig. 2. The cited references map of MOOCs (2009-2018)

To show how the frequently cited references have influenced the development of MOOCs, we list its top 5 by citation counts in Table 2.

Table 2. The top 5 cited references by citation counts

Count	Centrality	Year	Cited References
55	0.36	2013	BRESLOW LB, 2013, RES PRACTICE ASSESSM, V8, P13
54	0.29	2014	JORDAN K, 2014, INT REV RES OPEN DIS, V15, P0
54	0.08	2014	HEW KF, 2014, EDUC RES REV-NETH, V12, P45, DOI 10.1016/J.EDUREV.2014.05.001
49	0.10	2015	MARGARYAN A, 2015, COMPUT EDUC, V80, P77, DOI 10.1016/J.COMPEDU.2014.08.005
45	0.17	2013	KIZILCEC RF, 2013, P 3 INT C LEARN AN K, V0, PP170, DOI 10.1145/2460296.2460330]

The most frequently cited reference is Breslow (2013). As the director of the MIT Teaching and Learning Laboratory, Breslow introduces the first MOOC developed by edX, the joint venture between MIT and Harvard, and describes the research on the rich sources of the data it generated [7]. This article helps readers who are unfamiliar with MOOCs know more about how the important research has been carried out, what are the implications of their findings and the further directions of their research. Jordan (2014) studies the factors affecting the completion rates and attrition rates during the courses of MOOCs, which have been a controversial topic since 2012 when the phenomenon of incomplete courses attracted more and more attention [8]. This study aims to point out the challenges MOOCs are faced with and provide the implications for course design. Hew (2014) reviews the literature on the topic of students' and instructors' use of MOOCs to reveal the motivations and challenges of using MOOCs and presents the problems that have not been fully resolved [9]. This paper also suggests some reasons why students sign up for and drop out of MOOCs and instructors wish to teach MOOCs. Margaryan (2011) focuses on the nature of the use of digital technologies by undergraduate students by means of a questionnaire survey of students and interviews with students and lecturers [10]. Kizilcec (2013) discusses the central criticism against MOOCs, i.e. the relatively low completion rates of learners, presents a classification method where students are classified according to their patterns of interaction with video lectures and assessments, and suggests the future interventions, research and design directions for MOOCs [11]. These frequently cited publications suggest that MOOCs, as a completely new learning mode, are stimulating the reform of traditional education and the transmission of the open education idea.

3.3 The visualization analysis of research hotspots in MOOCs

Research hotspots are the topics discussed in a large amount of literature with inner link in a period of time. These issues are considered to be worthy studied in a certain field and are able to facilitate the understanding and interpretation of the topics under study and reveal the problems which have not been fully resolved. From the perspective of bibliometrics, the frequent occurring of keywords and the citation of scientific literature often presents the features of the research hotspots in a certain field. Keywords can directly show the theme and content of the publications, and the inner relations among the literature. The network of co-occurring keywords shows the hot words in relevant literature in certain timespan and makes clear the disciplinary structure, the status quo of research and the development history. On the platform of CiteSpace, the "time slicing" is set as "from 2009 to 2018", the "year per slice" as "1", and the "node types" as "keywords". The knowledge mapping is illustrated in Fig. 3.

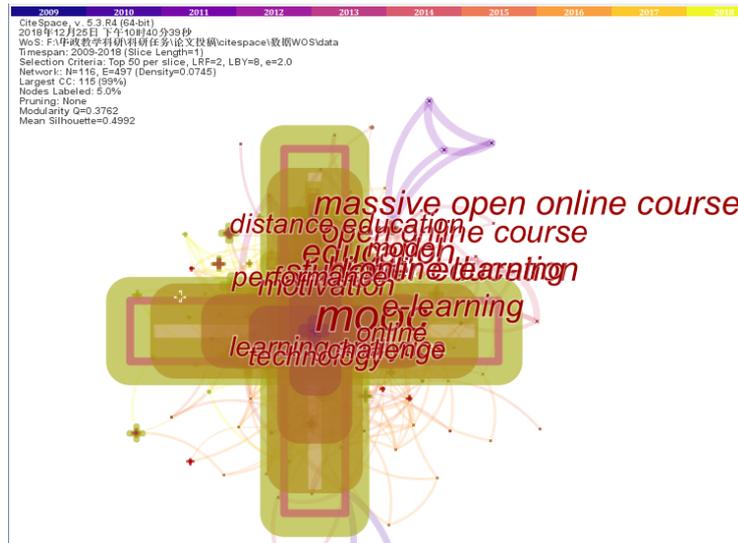


Fig. 3. The network of co-occurring keywords

Centrality is an essential indicator measuring the importance of a certain node type in the network. The higher the centrality of a certain node, the stronger it connects other nodes, which can be seen as the key node in the whole network. Keywords in Table 3 are the ones with the centrality larger than 0.05. Table IV presents the top 24 keywords of MOOCs by citation count.

Table 3. The top ranked keywords of MOOCs by centrality (2009-2018)

Centrality	Year	Keywords
0.41	2013	mooc
0.13	2011	connectivism
0.13	2014	community
0.11	2013	student
0.10	2013	education
0.10	2015	challenge
0.10	2014	science
0.09	2013	e-learning
0.09	2010	network
0.08	2015	learning analytics
0.07	2013	higher education
0.07	2015	motivation
0.07	2014	distance learning
0.07	2013	design
0.06	2013	online learning
0.06	2015	learning
0.05	2015	blended learning
0.05	2015	environment
0.05	2014	pedagogy
0.05	2015	open educational resource
0.05	2015	university
0.05	2015	experience
0.05	2015	social media
0.05	2014	internet

Table 4. The ranked keywords of MOOCs by citation count (2009-2018)

Count	...	Year	Keywords
701	...	2013	mooc
139	...	2013	education
130	...	2013	higher education
123	...	2013	massive open online course
92	...	2013	student
85	...	2013	online learning
77	...	2013	e-learning
76	...	2014	open online course
70	...	2015	motivation
49	...	2015	learning analytics
48	...	2016	performance
45	...	2014	technology
43	...	2014	model
43	...	2015	distance education
42	...	2015	challenge
40	...	2016	online
36	...	2015	open education
36	...	2014	massive open online courses (moocs)
32	...	2011	connectivism
32	...	2014	distance learning
32	...	2014	online education
30	...	2015	blended learning
30	...	2015	quality
30	...	2015	online course

Taking into consideration the two indicators of centrality and citation count, some keywords reveal the hot research issues in MOOCs and what researchers are really concerned with. Since “MOOCs” and “massive open online courses” are set as the topics when the data are searched, there is no doubt that they are among the top ranked keywords. The research hotspots of MOOCs reflected by the keywords are as follows.

(1) The influence of MOOCs on higher education. The keywords like “education”, “student”, “higher education”, “university” and “pedagogy” show that the studies of MOOCs mainly focus on the field of education, especially higher education, though it is a multidisciplinary topic. This echoes what Table 1 has illustrated. The rise of MOOCs highlights the position of online learning in higher education and makes the combination of information technology and higher education possible. The deep fusion of MOOCs and higher education has led to the revolutionary change of the university’s function in its traditional sense. Subbian (2013) thinks that MOOCs’ positive influence on teaching in higher education is shown in the five aspects of computer-aided learning, cross-disciplinary education and research, non-technological skills, teaching technology and students’ evaluation and explores its contribution to STEM education by using Coursera as a teaching case [12]. Daniel (2012) describes the evolving process of MOOCs from the early cMOOCs based on the theory of connectivism to the recent xMOOCs based on the theory of behaviorism, and points out the competition from MOOCs will force higher educational institutions to focus more on their teaching quality [13].

(2) The introduction and review on MOOCs. The keywords “e-learning”, “distance learning”, “online learning”, “internet”, “open online learning”, “technology”, “online”, “online education” and “online course” shows the open and online nature of MOOCs and the means by which they are carried out. They also reflect the idea of open education, which values highly the free sharing of knowledge. Literature about this research hotspot has mainly been published since the year of 2012. For example, Baggaley (2013) discusses the background of MOOCs’ rise, its features, classifications and people’s attitude towards it, and further explores MOOCs’ nature and its influence on the development of distance education [14]. Rhoads et al. (2015) introduce the background of MOOCs movement, analyzes the challenges to teaching and university teachers’ attitude towards MOOCs, and points out that MOOCs are beneficial to the reconstruction of the faculty [15].

(3) The supporting technology of MOOCs. The keywords “environment” and “technology” emphasize the application of new technologies to MOOCs’ construction, which are shown in the aspects of the optimization of teaching video, the construction of learning environment and the choice of learning platforms. For example, Fini (2009) constructs the technology-supporting framework by taking the course of CCK08 as a case and analyzes it from the three perspectives of the relationship between the lifelong education and open education, the management skills of individual knowledge and the usefulness of online learning tools [16]. Wagner et al. (2013) use 3D technology to construct

the virtual learning environments and apply it to the teaching practice of MOOCs [17]. Brinton et al. (2015) integrate the technologies of video, text, evaluation and social network into the mobile app and develop the platform of MIIC (Mobile Integrated and Individualized Course) [18].

(4) Learning activities and learners' features. This research hotspot is shown by the keywords "community", "student", "motivation", "learning analytics" and "performance", "design", "performance" and "quality". Researches of this type mainly focus on students' or instructors' motivation, attitude, and behavior features to the application of MOOCs. Studies on learners' behavior analyze the data from the learners on the learning platform to find out the features of their behavior patterns and predict their schooling performance. Studies on learners' motivation mainly focus on the psychological mechanism of learners' satisfaction and the formation mechanism of the online learning motivation and the continuous learning willness. Studies on learners' features are mainly concerned with the assessment of learners' online learning ability and effect. For example, Hew et al. (2014)'s study finds out that students' motivation behind the application of MOOCs are learning new knowledge, expanding their desire and curiosity for more information and instructors' motivation lies in the individual interests [19]. Milosevic et al. (2014) analyze the technology acceptance models and learning management systems (LMS) and make the following findings: the more MOOCs' advantages over LMS, the stronger the students' learning motivation; there exists the positive correlation between students' technology capability and the accessibility of LMS; students from different disciplines hold different views towards LMS; the lack of learning instruction leads to students' barrier in using LMS; LMS' function of social network has received students' favorable evaluation [20]. Kop et al. (2012) hold the view that education should turn its focus to "people", i.e. learners, and encourage the link between learners and instructors with the purpose of carrying out meaningful learning [21]. Cathy (2013) thinks that various evaluation methods should be tried to cope with the challenges in real teaching evaluation [22].

(5) The study on blended learning based on MOOCs. The keywords "challenge" and "blended learning" suggest this hotspot. In the era of post MOOCs, their shortcomings are increasingly becoming the issue under discussion. One of the challenges is that with the large number of students signing up MOOCs, only about 10% of them complete the courses. The educational institutions such as University of California and Harvard University criticize some teaching principles of MOOCs, advocate to replace MOOCs with SPOC, and encourage blended learning in universities [23]. Blended learning refers to the link of traditional classroom learning and online learning [24]. In this learning mode, students complete their curriculum and gain their credits in the two forms of both the automatic online learning of MOOCs and the offline learning such as asking and answering, discussing, grouping, etc. This blended learning mode also involves the blending of evaluation means, technologies, and the interaction between instructors and learners. The relevant studies often take a certain course as a case and introduces the teaching experiences, some of which test their teaching effect by means of experiment.

(6) The background knowledge about the birth of MOOCs. The keyword "connectivism" is closely connected with MOOCs. The rise of MOOCs is not an accidental event, but the transmission and development of the teaching concept of open education. The first MOOC was established by George Siemens and Stephen Downes in the year of 2008 and was named Connectivism and Connective Knowledge. As a theory of learning in a digital age, connectivism emphasizes the role of social and cultural context in how and where learning occurs. From the perspective of connectivism, knowledge is seen as a network and learning as a process of pattern recognition [25]. This learning theory is able to facilitate the interpretation of the rule of distributed online learning, where knowledge is considered as an organization rather than a structure and the acquiring of the nodes of knowledge is more important than the information in nodes. The process of learning is the process of constructing and traversing those nodes. Learners can explore knowledge by constructing the personalized learning environment and employing the online tools, build up the connection with other disciplinary experts, and actively participate in learning activities to achieve the purpose of stimulating their learning. Kop (2011) is the key literature in the study on MOOCs, which puts forward the three problems learners are faced with in the online learning environment: the critical thinking capability, the automatic learning

ability and their sense of immediacy [26]. This article also finds out that the positive effect of online learning relies in learners' confidence in taking part in the online learning activities, the meaningful interaction by means of various ways and the help from instructors and other learners.

These above-mentioned analysis of the research hotspot of MOOCs suggests that the studies have gradually transferred from the single perspective to the various perspectives, from the form level to the study on content, from the theoretical analysis to the practical exploration. It can be seen that studies on MOOCs are increasingly improved.

4. Conclusion

In this paper, we firstly generally review the research background of MOOCs, the hot issue in higher education and the research tool in this study, CiteSpace 5.3.R4. Secondly, we analyze the general trends and features of MOOCs by presenting the annual publications and the distribution of these publications. Then, we analyze the co-citation network of MOOCs by presenting the cited references map and the most frequently cited references of MOOCs. Finally we have the visualization analysis of research hotspots in MOOCs by means of the network of co-occurring keywords. In the near future, in the huge wave lead by MOOCs, higher education is becoming a complex and systemic project which is completed by faculty team and presents their comprehensive ability in the aspects of research, teaching, management and service. In the information age, teaching has increasingly grown up to a research frontier integrating learning science, information technology and big data, which is the interpretation, prediction and expectation for higher education from a broad perspective in the information era.

Based on the analysis of the status quo of MOOCs in this paper, the suggestions on future researches are as follows: (1) the empirical studies on MOOCs should be enhanced to find out the ways to solve the challenges in the educational theory and educational practice. (2) the cross-disciplinary research should be encouraged to meet the demands in the new era of big data. (3) more focus should be put on the new educational technologies to perfect the blended learning and deep learning. The reason behind this lies in the fact that the increasing application of the information technologies (such as artificial intelligence, virtual reality, augmented reality, natural user interface, etc.) into the educational field and the development of the learning system of next generation are to be bound to lessen the difficulties and cost of deep learning by means of constructing the virtualized, intelligentized and question-based learning situation, which will lead to the popularity of deep learning.

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