Chen, W. et al. (Eds.) (2017). Proceedings of the 25th International Conference on Computers in Education. New Zealand: Asia-Pacific Society for Computers in Education

A Bibliometric Analysis of 15 Years of Research on Open Educational Resources

Xiaochen WANG[a,b*], Mengrong LIU[b], Qianhui LI[a] & Yuan GAO[b]
[a] *Department of Educational Technology, Capital Normal University, China*
[b] *Smart Learning Institute, Beijing Normal University, China*
*wangxc_cnu@163.com

Abstract: Open educational resources (OER) has developed for fifteen years since the term was adopted for the first time in 2002. To explore its research development progress as well as research focuses, this study reviewed literature on OER from the year of 2002 to 2017 with a bibliometric method based on seven indicators including publication year, distribution by country/territory, distribution by institution, journals, authors, essays and keywords. The findings include: 1. the top five productive countries of OER related research consist of Spain, USA, England, Romania, and China, 2. geographic proximity is a predominant factor in co-authorships, 3. International Review of Research in Open and Distance Learning is the most influential journal in the field of OER, 4. UK Open University is the most productive institution, 5. the research hot spots include OER, e-learning, higher education, mooc, open access, teacher training, ICT and open textbooks, innovation, pedagogy, web 2.0, etc., 6. there are three stages of OER research: emergence stage (2002-2007), exploration stage (2008-2011) and application stage (2012-2017), 7. policy and funding are two crucial factors influencing OER movement, and 8. sustainability, copyright, higher education, MOOCs are worthy of researchers' attention. Hopefully this essay could draw a full picture of existing OER research, indicate its progress and frontiers, as well as provide implications for future work.

Keywords: Open educational resources, bibliometric analysis, CiteSpace, VOSviewer

1. Introduction

It is widely acknowledged that rapid development of information technology on one hand challenges traditional ways of education, and on the other hand, it provides new opportunities for teaching and learning (OECD, 2007). More specifically, "anyone can now learn anything from anyone at any time" (Bonk, 2009, p.6). In 2001, the MIT set up OpenCourseWare initiative (OCW), which made most MIT's course contents available online for the public, and it could be regarded as the origin of now called "open educational resource movement". The term "open educational resource" was adopted at a forum convened by United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2002, and the latest definition is "any type of educational materials in the public domain, or released with an open license that allow users to legally and freely use, copy, adapt, combine and share" (UNESCO, 2017).

In the past 15 years, a continuously increasing number of institutions, researchers, teachers, and learners have taken interests and made contributions in research and practice of OER, but few attempted to focus on drawing a global picture of OER literature so as to present a complete development progress of OER research as well as relevant situations. From this perspective, the present study aims to fill up this gap by reviewing and analyzing existing research on OER. In other words, it tries to quantify and visualize academic performance and cooperation at multiple indicators including country, institution, journal and author, generalize development trend of OER studies, explore hot spots and frontiers, and provide implications for further research.

2. Methods

2.1 Methods of Data Collection

The data was extracted from the Web of Science (WOS) database, which is an authoritative and widely recognized database for science analysis. As a part of WOS database, Web of Science ™ Core Collection database provides access to the world's leading scholarly literature in the sciences, social sciences, arts and humanities and examine proceedings of international conferences, seminars, workshops, conventions, etc.

Data collection was conducted on May 11th, 2017. As the term "open educational resources" came into use from 2002, we choose that year as the starting point of literature review. We carried out the data collection within the Web of Science TM Core Collection database through the following steps. Firstly, check "advanced search", "all languages", and "all document types" in the option box, selecting timespan from 2002 to 2017. Secondly, search with topic keywords "open educational resources" and "oer", which generated two collections of data with 2481 and 1786 records respectively. Thirdly, combine these two data collections with logical operator "OR", which ensures that all relevant literature is included. Fourthly, refine data by the "EDUCATION EDUCATIONAL RESEARCH" category, and get a total of 910 records. Fifthly, export the records (including full records and references) to a txt document. The operation record is presented in Figure 1.

# 4	910	#2 OR #1 **Refined by: WEB OF SCIENCE CATEGORIES:** (EDUCATION EDUCATIONAL RESEARCH) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=2002-2017*
# 3	3,918	#2 OR #1 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=2002-2017*
# 2	2,481	ts=oer *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=2002-2017*
# 1	1,786	ts=open educational resources *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=2002-2017*

Figure 1. Operation record of data collection

2.2 Methods of Data Analysis

Bibliometric analysis is the main method of data analysis in this study, which is a quantitative methodology of published academic literature (Broadus, 1987; Mayr & Scharnhorst, 2015) and has been proved feasible in social science (Nederhof, 2006). According to van Raan (2003), bibliometric analysis could be performed at three levels: macro-level (e.g., countries), meso-level (e.g., institutions, universities) and micro-level (e.g., departments, research groups). His idea was adopted in terms of performance analysis.

With advanced tools, the exploration and visualization of distribution of publications, academic collaboration, development trend, and research focus can be effective and efficient. In this study, two software programs were adopted: CiteSpace and VOSviewer. Both of them are featured by visualization of literature. The former specializes in detecting and visualizing development trends and transient patterns (Chen, 2006), while the latter have superiority of clustering, network and density visualization. A combination of these two programs contributes to a more comprehensive explanation of OER literature.

3. Results

3.1 Publication Year

Figure 2 shows the publication year of OER literature, by which it can be seen that from 2002 to 2009, OER publications experienced a slow but relatively steady increase from 3 to 21. Then the figure increased by almost 3 times in 2010 to 66. After that, from 2011 to 2014, there was a stable growth from 66 to 134. In 2015, the figure reached the peak with a total of 182 publications. Although the number dropped a little in 2016, it still indicated a substantial outcome.

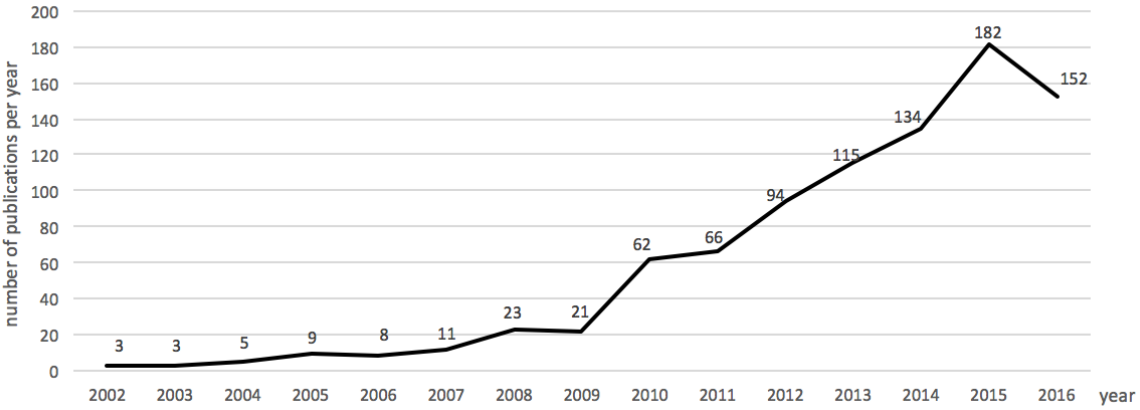

Figure 2. publication year

3.2 Distribution by Country/ Territory

The publications in the past 15 years were distributed across 86 countries and territories, while the top 10 countries contribute to over 70% of the whole publications. As the Table 1 shows, Spain is the most productive country with 132 publications, which took up 14.5% of 910 records. The following four top productive countries are USA, England, Romania, and People's Republic of China, respectively.

Table 1: Distribution by country/ territory

Rank	Country	Number of Publications (NP)
1	Spain	132
2	USA	120
3	England	118
4	Romania	80
5	People's Republic of China	41
6	Canada	34
7	Mexico	33
8	Germany	28
9	Australia	28
10	Italy	26

Figure 3 visualized the co-authorship network by country. Circle colors represent cooperation clusters. In other words, countries belonging to one cluster cooperated more with each other than with countries in other clusters. The size of circles refers to the number of publications of the country whose name is on it, and the lines stand for co-authorship relationship. Thicker a line is, more co-authorships existed between the two countries linked by it. This figure indicates that although there were a few long-distance co-authorships such as one between Canada and India, most co-authorships rely on geographic proximity. In addition, Spain, Germany, England, Italy and Greece are the top five countries with the highest co-authorships.

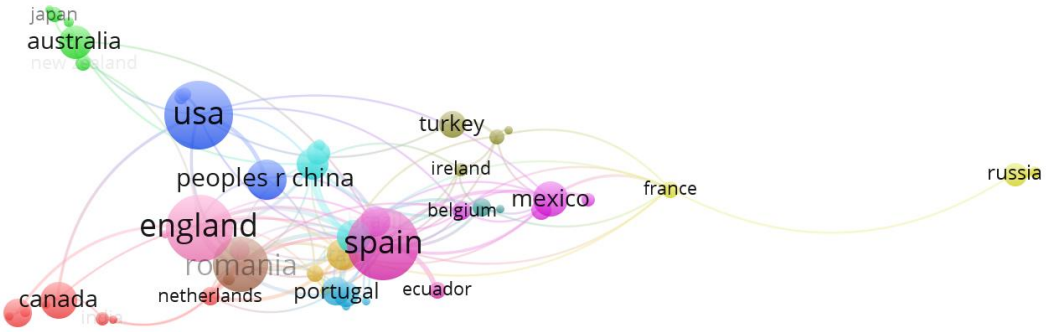

Figure 3. Visualization of co-authorships by country

3.3 Journals

Number of publications and cited frequency are two important indicators of journal influence. Table 2 and 3 list the top 9 journals with the highest publications and citation frequency (of essays regarding OER) respectively. With the highest publications and citations, International Review of Research in Open and Distance Learning was obviously the most influential journal in OER research. British Journal of Educational Technology and Distance Education provide valuable insights as well.

Table 2: Journals with the highest publications on OER

Rank	Journal Name	NP
1	International Review of Research in Open and Distance Learning	50
2	Open Praxis	26
3	EDULEARN14: 6th Annual International Conference on Education and New Learning Technologies	21
4	EDULEARN 11: 3rd International Conference on Education and New Learning Technologies	21
5	International Review of Research in Open and Distributed Learning	20
6	EDULEARN15: 7th International Conference on Education and New Learning Technologies	19
7	INTED2014: 8th International Technology, Education and Development	18
8	British Journal of Educational Technology	17
9	Distance Education	16

Table 3: Journals with the highest citation frequencies of OER publications

Rank	Journal Name	Citation Frequency
1	International Review of Research in Open and Distance Learning	164
2	Computers & Education	98
3	Journal of Interactive Media in Education	74
4	Open Learning: The Journal of Open, Distance and e-Learning	69
5	British Journal of Educational Technology	67
6	Distance Education	58
7	Interdisciplinary Journal of Knowledge and Learning Objects	57
8	Educational Technology & Society	54
9	Educational Technology Research and Development	49

3.4 Distribution by Institution

Authors come from over 800 institutions, and Table 4 lists the top 11 productive institutions and their countries. UK Open University ranked as top one with absolute superiority over the second productive institution, Brigham Young University in USA, followed by Tecnológico de Monterrey in Mexico, Athabasca University in Canada and University of Nottingham in England.

Table 4: Distribution by institution

Rank	Institutions	Country	NP
1	Open University	England	41
2	Brigham Young University	USA	17
3	Tecnológico de Monterrey	Mexico	15
4	Athabasca University	Canada	13
5	University of Nottingham	England	10
6	University of Alicante	Spain	9
7	West University of Timișoara	Romania	8
8	Utah State University	USA	8
9	Politehnica University of Timisoara	Romania	8
10	Universidad Nacional de Educación a Distancia	Spain	8
11	University of Bucharest	Romania	8

3.5 Authors

There are over 2000 authors including both first and co-authors. Table 5 shows the top 11 authors ranked by number of publications and citations. Wiley D, Holotescu C were the top two authors with ten publications per person, and Wiley's publications have won the highest citation frequency. Besides essays, reports from some influential organizations like UNESCO and OECD were highly cited as well.

Table 5: Authors rank

Rank	author	NP	author	Citation Frequency (CF)
1	Wiley D	10	Wiley D	111
2	Holotescu C	10	UNESCO	104
3	Grosseck G	8	Downes S	91
4	Hilton J	8	OECD	69
5	Mcandrew P	6	Atkins D E	62
6	Lane A	6	Siemens G	49
7	McGreal R	6	Hylen J,	44
8	Stapleton S	6	Conole G	43
9	Andone D	5	Weller M	35
10	Montoya MSR	5	Mcgreal R	31
11	Beggan A	5	Dantoni S	29

3.6 Essays

Highly cited essays serve as essential knowledge resource and foundation in a research field, which can reflect development level, hotspots and advancing directions (Li & Zhang, 2016). Table 6 lists the top 15 cited essays. After reviewing essays in the list, we found that one third of the essays focus on the OER itself, trying to provide a full picture of OER. The detailed explanations of these essays will be discussed in the next section concerning hot spots.

Table 6: Top 15 cited essays

Rank	Authors	Year	Essay	CF
1	Atkins D, E	2007	A review of the open educational resources (OER) movement: Achievements, challenges, and new opportunities	54
2	OECD	2007	Giving knowledge for free: The emergence of open educational resources	39
3	Downes S	2007	Models for sustainable open educational resources	24
4	Butcher N	2011	A basic guide to open education resources (OER)	12
5	Weller M	2014	Battle for open: How openness won and why it doesn't feel like victory	12
6	Hilton J	2010	The four 'R's of openness and ALMS analysis: frameworks for open educational resources	9
7	Yuan L	2013	MOOCs and open education: Implications for higher education	9
8	Geser G	2007	Open Educational Practices and Resources - OLCOS Roadmap 2012	8
9	Allen IE	2014	Opening the curriculum: Open educational resources in US Higher Education	7
10	Willems J	2012	Equity considerations for open educational resources in the globalization of education	6
11	Mcauley	2010	The MOOC model for digital practice	6
12	De Los Arcos B	2014	OER evidence report 2013-2014	6
13	Liyanaguna wardena TR	2013	MOOCs: A systematic study of the published literature 2008-2012	6
14	Peter S	2013	On the role of openness in education: A historical reconstruction	5
15	Wiley D	2007	On the sustainability of open educational resource initiatives in higher education	5

3.7 Keywords

Table 7: Keywords list

Rank	Keywords	Frequency	Rank	Keywords	CF
1	open educational resources	175	12	ICT	16
2	oer	96	13	open textbooks	15
3	e-learning	64	14	distance education	15
4	higher education	58	15	innovation	15
5	mooc	44	16	learning objects	15
6	education	35	17	learning	15
7	open education	34	18	pedagogy	14
8	MOOCs	27	19	web 2.0	14
9	Online learning	20	20	educational technology	14
10	open access	18	21	blended learning	13
11	Teacher training	17	22	open educational resources(oer)	13

There are over 2000 keywords in the collection and Table 7 shows the top 22 appeared keywords. As the table shows, apart from OER itself, e-learning, higher education and mooc are mostly discussed.

Open access, teacher training, ICT and open textbooks, innovation, pedagogy, web 2.0, etc. are also hot issues related to OER.

To track the path of OER research focus, an analysis of keywords co-occurrence on timeline was conducted and the result was shown in Figure 4. There are three obvious clusters of keyword occurrence with representative words of “higher education”, “student”; “open educational resource”, “e-learning”, “educational technology”, “web 2.0”; and “learning object”, “mooc”, “innovation”, “online learning”.

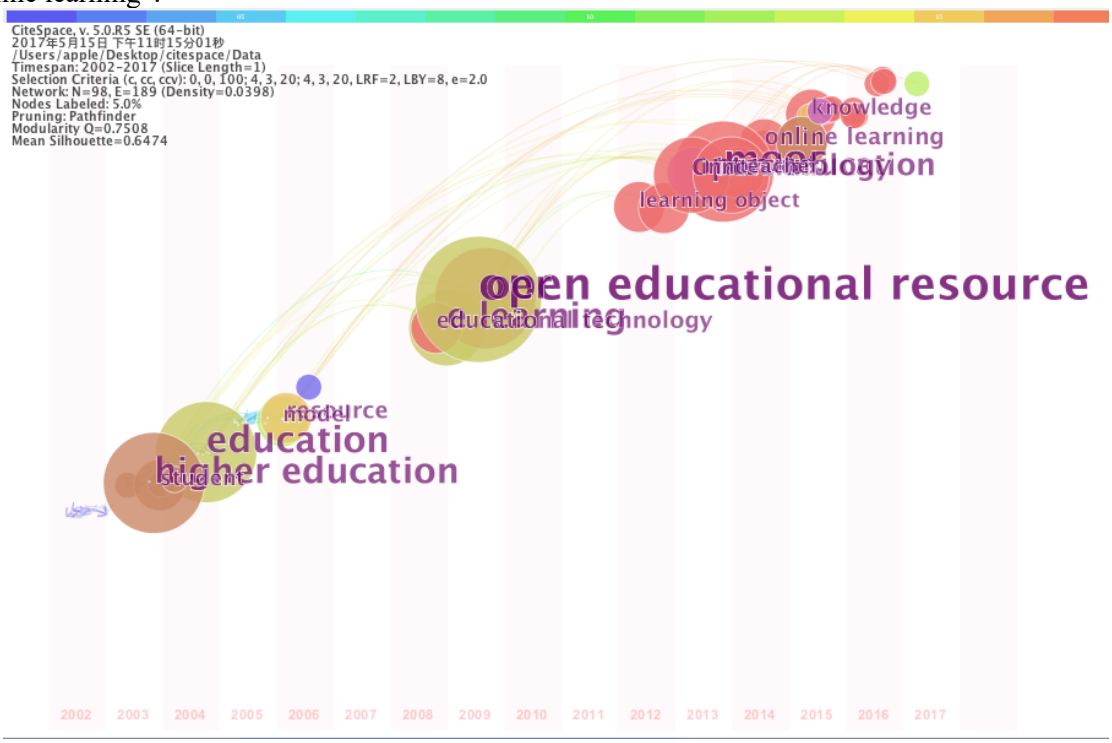

Figure 4. Time zone chart of keywords

4. Discussion

4.1 Development Trend

The publication year of OER research and time zone chart of keywords provide clues for development trend of OER research. As Figure 4 shows, there are three clear clusters of OER focus. With consideration of important conferences and forums on OER together, we concluded the development trend of OER research into three stages.

Emergence (2002-2007): In the early five years from adoption of term “OER”, there was a slowly increasing awareness of OER practice and study. The top keywords in this period include “higher education”, “education”, “resource”, “model”, “student”, etc. The main institutions involved in OER movement are universities, and students are at the center. Most studies concentrate on basic conceptual issues of OER, such as definition, characteristics and contents.

Exploration (2008-2011): In this stage, an overwhelming trend, web 2.0, has influenced education and OER significantly. Besides “open educational resource”, the top keywords in this stage also include “e-learning”, “educational technology”, and “web 2.0”, indicating that researchers tried to figure out technological issue of OER. In addition, international conferences in this period focused on awareness increasing and popularization of OER with the key interests of exploration of benefits that OER could bring to the public.

Application (2012-2017): A richer cluster of keywords appeared in this stage such as “mooc”, “technology”, “ICT”, “online learning”, “knowledge”, “innovation”, “learning object”, “teacher”, “connectivism”, “pedagogy”, “mobile learning”, “teacher training”, “learning analytics”, “open access”, etc.. It indicates that OER research has reached a more comprehensive level; meanwhile, OER practice

has spread to broader fields such as innovation promotion, teacher training, and learning analytics. In accordance with keywords result, conferences during this period also focus on application of OER, including OER guidelines and policies.

4.2 Bursts Detection

The burst detection reveals sudden improvement of citation in countries, and the results were shown in Figure 5. Due to space consideration, we take England and China as examples for discussion.

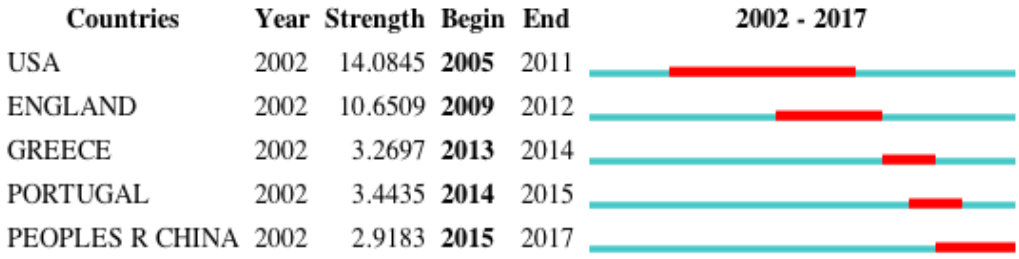

Figure 5. Citation burst detection

There is a solid evidence for the burst from 2009 to 2012 in England. It was in accordance with the duration of a national programme called UK Open Educational Resources (UKOER) programme. In this programme, over 80 projects have received funding and worked under the programme framework. The institutions involved has produced a great deal of academic outcome and experienced increased academic reputation. What is more, the projects not only focused on resource development, integration and popularization, but also attempted to address relative issues related to OER application such as the use of Creative Commons (CC) licenses in education, benefits gained by stakeholders, appropriate interfaces, successful business models, etc.

As for the case of People's Republic of China, to a great extent, the burst appeared owing to an educational policy released by the Ministry of Education in late 2014, named <Implementation of effective mechanism of expanding high-quality educational resource coverage with information technologies>. Under this framework, it highlighted the "three accesses and two platforms" which stands for "every school has access to broadband networks, every class has access to qualified resources, every learner has access to online learning space" and two public service platforms for educational resources and educational management. The policy has stimulated investment and inspiration in OER development and research. Before long, in 2015, the Ministry of Education published an educational plan named <Strategic plan for higher professional education innovation development (2015-2018)>. The policy pointed out the importance of developing co-construction and sharing system of digital resources, promoting development of high-quality and high professional resources based on market and regional demand.

The evidences shed light on the vital role of funding and policy in OER development and sustainability.

4.3 Research Focuses

According to keywords analysis, the research focuses of OER include e-learning, mooc, education, open education, online learning, open access, teacher training, ICT, open textbooks, distance education, innovation, learning objects, pedagogy, web 2.0, educational technology, blended learning, connectivism, evaluation, mobile learning, technology, distance learning, professional development, sustainability. With referencing to highly cited essays, we conclude four major topics concerned by OER stakeholders and researchers.

Sustainability is a core issue and major challenge faced by not only end-users but also OER developers, foundations and policy makers. Sustainability, in this context, refers to the ongoing ability of an OER project to make its goals come true (Wiley, 2007). Many may consider this issue from an

economic perspective and try to find an operational business model to sustain OER projects in long-run. However, sustainability is not restricted to financial problems, and it is unrealistic to build a one-fit-all model owing to the differences of OER projects (Wiley, 2007). Although funding is important, in a larger picture, calculation of other surrounding issues such as content management, organization operation and technical maintenance, is also necessary (OECD, 2007). Therefore, Downes (2007) categorized the sustainable OER models into four aspects: funding, technical, content and staffing. Wiley (2007), argues for two main challenges for OER projects' sustainability: production and sharing, as well as use and reuse.

Copyright issues are at the heart of OER (Atkins, Brown & Hammond, 2007). There is an inevitable confliction between rights-holders and public good, so the thing need to be done is seeking for an appropriate balance, which is also the basic rationale of open licenses. But there is a common misconception: content released under an open license belongs to the public, so all users can adapt and reuse it (Butcher, 2011). This could be verified by the OER evidence report (de los Arcos, Farrow, Perryman, Pitt& Weller, 2014), which found that over 80% of informal learners make adaptions to resources, but only 18% of them do it after confirmation of their rights to do so. In fact, none of open licenses is a "yes" or "no" switch, there are different levels of openness. The most widely applied open license in OER, Creative Commons license, defines seven levels of openness (from the most openness to the least): CC 0, Attribution, Attribution-ShareAlike, Attribution-NoDerivates, Attribution-NonCommercial, Attribution-NonCommercial-ShareAlike, Attribution-NonCommercial-NoDerivates. Under this framework, right holders of resources can decide their rights to reserve. At the same time, the public can use these resources within the permissive space.

Higher education is the main sector for OER movement. This is understandable given the fact that in the information age, all countries are trying their best to ensure citizens have access to quality tertiary education, but universities do not open their gates to everyone, especially the "elite" ones. That is why the OpenCourseWare initiative broke the wall of university and provide high-quality educational resources to the public. After that, an extraordinary sharing trend spread through worldwide institutions, organizations and even individuals. They made great contributions to social equity, not nationally but globally. Although higher education may be the main filed of OER still, K12 education and professional training are making efforts to keep in pace.

Massive open online courses (MOOCs) was originally used to describe a course called "Connectivism and connective knowledge", which was initially designed for 25 formal students to study for credit and open registration of worldwide learners, and surprisingly got over 2300 registers by its end (Yuan &Powell, 2013). The emergence and development follows the trend of openness in education and OER movement (Yuan, MacNeill & Kraan, 2008). Some may have confusion between OER and MOOCs. In fact, MOOCs, as complete courses including instructions and assessments, could be regarded as a subset of OER, which consist of learning content, tools and implementation resources. However, a great deal of open educational resources, appeared as the formation of MOOCs such as Coursera, Udacity and edX.

5. Conclusion

It is undeniable there are limitations of this study. Firstly, there is no possibility that a database can cover all the publications in a fast growing filed (Wang & Liu, 2014), not to mention that research outcomes are published in various languages. Therefore, it is inevitable that we might miss some articles due to the limitation of database and data collection. Nevertheless, Web of Science database provides a relatively comprehensive collection of core academic outcomes, which help us to obtain a relatively rational results. Secondly, due to space consideration, some findings could not be discussed in detail. Given the fact that the goal of this essay is to provide a full picture of OER research rather than a deep analysis, we strongly suggest reading essays in terms of specific issues which can provide deeper insights.

To sum up, this study reviewed OER literature from 2002 to 2017 with a bibliometric method. The results include publication years, distribution by country, institution and journal. Influential authors and essays were also extracted. With the results related to publication year and keywords clusters, the development of OER research falls into three stages: First stage of an emergence, during which the

researches focus on the definition, features and contents of OER, and tried to increase the public's awareness. Second stage of an exploration, during which the research focus referred to technological issues and serviceability; third stage of. an application, during which the research focus became more comprehensive and practical. The burst detection in countries indicate that policy and funding are two crucial factors influencing OER movement, consequently are much concerned by stakeholders. Apart from them, sustainability of initiatives, copyright issues, higher education, MOOCs are worthy of researchers' attention. Although some issues encountered just once such as innovation and pedagogy, they should not be overlooked. Instead, both practice and research should be placed in a full picture and considered carefully.

Acknowledgements

We would like to thank funding and support from Research on Co-creation, Sharing, Promotion and Implementation of Open Educational Resources along the Belt and Road Initiative, A national general project in educational science in "the 13th Five-year Plan". 2017, BCA170073.

References

Bonk, C. J. (2009). The world is open: How web technology is revolutionizing education. John Wiley & Sons.

Broadus, R. N. (1987). Toward a definition of "bibliometrics". *Scientometrics, 12* (5-6), 373-379.

Chen, C. (2006). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for information Science and Technology, 57*(3), 359-377.

Dholakia, U., King, J., & Baraniuk, R. (2006, May). What makes an open education program sustainable? The case of Connexions. In *Open Education Conference* (vol. 2340).

Li, Y., & Zhang, M., (2016). A bibliometric analysis of research on international open educational resources and MOOCs (2002-2015). *Journal of Distance Education, 34*(3), 76-87.

Mayr, P., & Scharnhorst, A. (2015). Scientometrics and information retrieval: weak-links revitalized. *Scientometrics, 102*(3), 2193-2199.

Nederhof, A. J. (2006). Bibliometric monitoring of research performance in the social sciences and the humanities: A review. *Scientometrics, 66*(1), 81-100.

OECD. (2007). Giving knowledge for free: The emergence of open educational resources. Retrieved April 29, 2017, from http://www.oecd.org/dataoecd/35/7/38654317.pdf

UNESCO. (2017). 2nd world OER congress: outcomes and recommendations. Retrieved August 10, 2017, from http://www.oercongress.org/wp-content/uploads/2017/07/WOERC-2017-Outcomes-and-Recommendation-Document-V1-EN.pdf

van Raan, A. F. (2003). The use of bibliometric analysis in research performance assessment and monitoring of interdisciplinary scientific developments. *Technology Assessment-Theory and Practice*, *1*(12), 20-29.

Wang, J., & Liu, Z. (2014). A bibliometric analysis on rural studies in human geography and related disciplines. *Scientometrics, 101*(1), 39-59.

Wiley, D. (2007). On the sustainability of open educational resource initiatives in higher education. Paper commissioned by the OECD's Centre for Educational Research and Innovation (CERI) for the project on Open Educational Resources.

Yuan, L., MacNeill, S., & Kraan, W. G. (2008). Open Educational Resources-Opportunities and challenges for higher education. Retrived April 29, 2017, from http://publications.cetis.org.uk/wp-content/uploads/2012/01/OER_Briefing_Paper_CETIS.pdf

Yuan, L. and Powell, S. (2013) 'MOOCs and Open Education: Implications for Higher Education'. CETIS White Paper, Retrieved May 7, 2017, from http://publications.cetis.org.uk/wp-content/uploads/2013/03/MOOCs-and-Open-Education.pdf.