Massive Open Online Courses (MOOCs) in Higher Education: A Bibliometric Analysis (2012-2022)

Irwanto Irwanto*, Dwi Wahyudiati, Anip Dwi Saputro, and Isna Rezkia Lukman

***Abstract*—Nowadays, Massive Open Online Courses (MOOCs) have become an increasingly popular online learning environment. However, existing studies did not offer comprehensive findings and deeper exploration of MOOCs. This study presents a bibliometric review of 3201 studies up to 2022 from the Scopus database. Although the first study was conducted in 2012, most of the studies were published in 2021. The literature on MOOCs is growing significantly and this pattern is expected to increase in 2022 and beyond. The most cited documents were written by Liyanagunawardena *et al.*, Jordan, and Hew and Cheung. *ACM International Conference Proceeding Series* is the most relevant publishing venue, followed by *Lecture Notes in Computer Science* and *CEUR Workshop Proceedings*. The Open University, Massachusetts Institute of Technology, and Universidad Nacional de Educacion a Distancia are playing important roles in MOOC studies. Besides China, which significantly outperforms other countries, the US and UK dominate in the field. Concerning the most active authors, D. Andone and D. Burgos stand out in MOOCs literature. The most frequent keywords are "*MOOC*", "*MOOCs*", "*Higher Education*", "*E-learning*", and "*Massive Open Online Courses*". This study maps the scientific production regarding MOOCs, which will be useful for future collaborations and provide a framework for future studies.**

***Index Terms*—Bibliometric, MOOCs, massive open online courses, higher education.**

I. Introduction

Massive Open Online Courses (MOOCs) have become an increasingly popular online learning environment in recent years and also received interest and attention from researchers worldwide. This is because of the innovative ways that technology has brought into the education system, especially since the outbreak of COVID-19, helping students around the world improve their knowledge and skills. During the COVID-19 pandemic, MOOCs have replaced traditional teaching styles. The rapid shift from offline teaching to MOOCs is a form of emergency response to the spread of the pandemic; thus, learners should also quickly adapt their teaching form. Because it is considered a platform that can expand access to higher education, MOOCs are seen as "the next evolution of networked learning" [1]. In fact, MOOCs have been reported to have a significant impact on online education since their emergence more than a decade ago [2]. In other words, MOOCs have shown great potential to provide free and open courses to large numbers of students from anywhere without requiring prerequisites for participation [3, 4]. In addition, MOOCs provide learning flexibility with regard to time and place and allow a variety of assignments in one course [5].

Because they utilize e-learning platforms, MOOCs are conceptualized as "online courses designed for large numbers of participants, that can be accessed by anyone anywhere as long as they have an internet connection, are open to everyone without entry qualifications, and offer a full/complete course experience online for free" [6]. In this context, "massive" refers to no enrollment restrictions; thus, it can be offered to a large number of students, "open" means students are free from geographical restrictions, entry requirements, course sizes, financial limitations, etc. and "online" refers to learning via the internet [7]. Over the last ten years, MOOCs have rapidly expanded globally and evolved into several forms. In general, Downes [2] categorizes MOOCs into two main types: first, cMOOCs are based on connectivity theory [8] and focus on communicative interactions between learners, teachers, and resources, and second, xMOOCs are based on a behaviorist pedagogical approach and focus on the traditional lecture formats that exist in universities [9]. With their various advantages, it can be said that MOOCs are the latest development of distance education that enables lifelong learning [10].

MOOCs originated in the US when David Wiley created the first MOOC, or proto-MOOC, at Utah State University in August 2007 and opened it for anyone to participate online [11]. However, in 2008, Dave Cormier and George Siemens first coined the term "MOOC" to describe an open course created by George Siemens and Stephen Downes at the University of Manitoba [12]. Since then, MOOCs have received significant attention. Nowadays, international MOOC providers such as Udacity, FutureLearn, Coursera, and edX [13, 14] have offered many MOOC courses around the world. They also have partnered with hundreds of universities [15] to design MOOCs that align with the country's needs. In 2021, Shah [16] reported that more than 19 thousand MOOCs were offered by 950 different universities with enrollments of 220 million students worldwide (an increase of 40 million students compared to the previous year). As the number of MOOC participants continues to increase throughout the years, MOOCs have gained considerable academic attention.

Along with the increasing popularity of MOOCs among scholars, a large number of literature reviews on MOOCs have been carried out in the past decade. For example, Al-Rahmi *et al*. [17] conducted a systematic review of MOOCs and analyzed 219 articles published between 2012

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and 2017. Similarly, Sezgin and Cirak [4] investigated 82 peer-reviewed articles published between 2014 and 2019 from five scientific databases. Furthermore, Veletsianos and Shepherdson [18] also conducted a systematic review of 85 conference papers and 98 research articles published between 2013 and 2015 from the Scopus database. Moreover, Zhu *et al*. [19] reviewed 541 empirical MOOC research published between 2009 and 2019 from the Scopus database. Recently, Modise [20] conducted a systematic review of 15 peer-reviewed journal papers published from 2013 to 2020. However, previous reviews have analyzed only a limited number of documents; thus, possibly limiting the research findings. In fact, almost all systematic reviews analyzed articles published before 2020. The majority of previous studies used systematic reviews rather than bibliometrics. Although Liu *et al*. [7] conducted a bibliometric review, they only focused on research trends in MOOCs up to 2019. Thus, existing studies did not offer comprehensive findings and deeper exploration of MOOCs. Given that there has been more research on MOOCs after 2019, further bibliometric analysis is highly needed.

In contrast to earlier studies, this bibliometric study examined 3201 articles over the past decade. Therefore, it provides an up-to-date overview of trends in research on MOOCs in higher education in terms of the annual publications and citations, the most frequently cited papers, the most influential sources, institutions, and countries, the most prolific authors, and the distribution of author keywords. The significance of the current study is that, to the best of our knowledge, there have been no previous bibliometric studies of MOOCs in higher education. Accordingly, the current review aims to address the following research questions (RQ):

RQ1. What are the publication and citation trends throughout the year?

RQ2. Which are the most cited references, most productive sources, universities, and countries?

RQ3. Who are the most prominent authors?

RQ4. What is the status of co-authorship for authors and countries and the distribution of author keywords?

II. Methodology

A. Study Design

This review aims to examine the studies on MOOCs by using a bibliometric mapping method from a global perspective to analyze the trends and status of the publication, citation, author, journal, institution, country, and keyword variables. Bibliometric analysis is a popular statistical method for exploring and analyzing large amounts of scientific data in a particular field [21].

B. Data Collection

A set of 3201 documents were collected through the Scopus database (http://www.scopus.com/). They have been cited by 27,290 other papers or the equivalent of 8.53 citations per article. Scopus was selected because it covers a wider range of documents than other scientific databases [22]. Scopus is the world's largest abstracting and indexing database covering 84 million records from more than 25.8 thousand active peer-reviewed journals and 10.9 million conference papers published by more than 7000 publishers [23]. Scopus offered a wide range of disciplines relevant to the internationalization of higher education and provides easy access to bibliographic data [24]. In addition, it covered a wider range of educational disciplines than other databases, for example, Web of Science (WoS) [25]. Therefore, using the Scopus database allowed researchers to shed more light on topics that might not be available in WoS.

The search returned a total of 3201 documents after applying the inclusion and exclusion criteria. These criteria are presented in Table I.

TABLE I: Inclusion and Exclusion Criteria

Criteria
Inclusion Criteria (IC)
IC1. The keyword search was limited to the title, abstract, and keywords of the document
IC2. Documents written in the English language
IC3. Documents focused on MOOCs in Higher Education
IC4. All date of publication
IC5. All types of documents
Exclusion Criteria (EC)
EC1. Documents published in non-English language
EC2. Documents not related with MOOCs
EC3. Documents focused on MOOCs in secondary schools

The data search process in this study, which refers to the framework of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; [26]), is presented in Fig. 1.

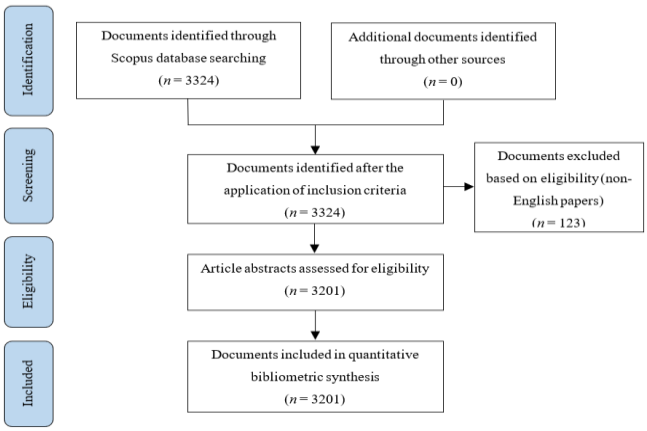

Fig. 1. The research protocol.

The metadata set was acquired on July 25, 2022, without limiting the year. We also considered all types of documents (e.g. books, book chapters, conference reviews, reviews, editorials, and short surveys). It aimed to provide a deeper understanding and clearer picture of this field in the past 10 years. The following primary search was performed to find these articles: TITLE-ABS-KEY ((“massive open online course*” or “MOOC*”) and (“higher education” or “tertiary education” or “universit*” or “undergraduate*” or “college*”)). When the data set was checked, it was found that the selected articles related to MOOCs consisted of 103 countries and 7 different languages. It is noteworthy that one article may be written in at least two different languages.

C. Data Analysis

The first two authors independently searched for articles

from the Scopus database and then evaluated the screened studies. The assessment started with their title, abstract, and keywords. The documents that meet the requirements were then collected. The second two authors then performed independent data extraction. They also classified each document based on the author's name, year, publishing venue, institution, country, and the number of citations.

Of the 3201 documents, 44.86% were proceeding papers (*n*=1436), 39.02% were journal articles (*n*=1249), and 16.12% were other document types (*n*=516). The data were then exported as CSV (comma-separated values) and RIS (research information systems) files. This study performed Microsoft Excel to analyze the data. Most of the data were presented in the form of percentages and frequencies. Due to its ease of use, we also used the VOSviewer (https://www.vosviewer.com/) to visualize bibliometric networks [27], for example, co-authorship, keyword co-occurrence, and citation analyses. The results of the analysis were presented in the form of tables and network visualization maps. The size of the nodes represents the number of articles, while the line width between nodes indicates the intensity of collaboration. Note that keywords that appear frequently together in published documents were coded in the same color and then grouped in the same cluster.

III. Results

A. Publication and Citation Trends

The search results inform that a total of 3201 documents have been published during the period of 2012-2022 years. Fig. 2 depicts the number of annual publications and cumulative citations on MOOCs throughout the year.

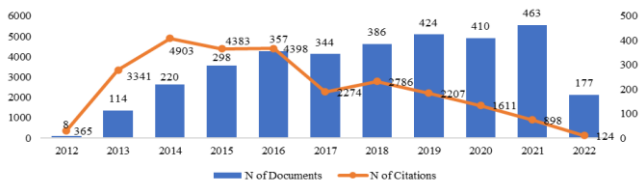

Fig. 2. Distribution of publications on MOOCs by year.

The first publication on MOOCs in higher education appeared in 2012 with 8 documents. In the first 5 years period (2012-2016), there were 997 documents (31.15%) with an annual number of 199 publications. In the second 5-year period (2017-2021), the number of studies in this area increased significantly, and 2027 documents were published (accounting for 63.32% of publications). In 2022 (until this study was conducted), the number of publications reached 177 articles (5.53%). In terms of the number of citations, this trend continues to increase from year to year, which corresponds to the increase in the volume of publications in the field. So far, the total citations are 27,290, or the equivalent of 8.53 citations per paper. This growth indicates that MOOCs in the context of higher education are attracting the attention of more researchers.

B. Highly Cited Documents

The top 10 most highly cited documents throughout the year are presented in Table II. In terms of the most frequently cited documents based on the number of citations (C) and average citation per article (C/A), Liyanagunawardena *et al.*'s [28] article entitled *MOOCs: A systematic study of the published literature 2008-2012* occupies the first place with 691 citations (76.78 per year). The top two most cited articles are *Initial trends in enrollment and completion of massive open online courses* written by Jordan [29] with 525 citations. Then, Hew and Cheung's [30] work entitled *Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges* occupies third place with 518 citations and 64.75 per year. In general, there are 38 articles that have more than 100 citations; 3.37% of documents have more than 50 citations and 19.09% have more than 10 citations; 67.35% of publications received at least one citation. This reflects that most of the publications of MOOCs attract the attention of researchers around the world.

TABLE II: Top 10 Most Cited References

Author(s)	Document Title	Source	C	C/A
Liyanagunawardena *et al.* [28]	MOOCs: A systematic study of the published literature 2008-2012	IRRODL	691	76.78
Jordan [29]	Initial trends in enrolment and completion of massive open online courses	IRRODL	525	65.63
Hew and Cheung [30]	Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges	ERV	518	64.75
Hone and El Said [31]	Exploring the factors affecting MOOC retention: A survey study	CE	343	57.17
Kaplan and Haenlein [32]	Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie	BH	336	56.00
Littlejohn *et al.* [33]	Learning in MOOCs: Motivations and self-regulated learning in MOOCs	IHE	313	52.17
Fox [34]	From MOOCs to SPOCs	CACM	226	25.11
Martin [35]	Will massive open online courses change how we teach?	CACM	211	21.10
Gašević *et al.* [36]	Where is research on massive open online courses headed? A data analysis of the MOOC research initiative	IRRODL	198	24.75
Mehta *et al.* [37]	Just imagine: New paradigms for medical education	AM	197	21.89

Notes: IRRODL: International Review of Research in Open and Distributed Learning; ERV: Educational Research Review; CE: Computers and Education; BH: Business Horizons; IHE: Internet and Higher Education; CACM: Communications of the ACM; AM: Academic Medicine.

C. Most Productive Sources

In this study, the collection of 3201 documents was published in 1219 different publishing venues. Only 41 (3.36%) sources published 10 or more documents. The top 10 most productive sources regarding the number of total

articles (A) are presented in Table III. Accordingly, these 10 sources have published 651 documents, accounting for 20.34% of the publication with a number of citations of 4741 (17.37%). The ACM International Conference Proceeding Series has the largest number of articles published in this area with 136 papers and 616 citations. The *Lecture Notes in Computer Science including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics* and *CEUR Workshop Proceedings* rank from 2nd to 3rd, respectively. *International Review of Research in Open and Distance Learning*, based in Canada, had the highest number of citations per document, followed by *Education and Information Technologies* and the *International Journal of Emerging Technologies in Learning*.

TABLE III: TOP 10 MOST PRODUCTIVE SOURCES

Source	A	C	C/A
ACM International Conference Proceeding Series	136	616	4.53
Lecture Notes in Computer Science including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	110	374	3.40
CEUR Workshop Proceedings	78	114	1.46
International Review of Research in Open and Distance Learning	62	2849	45.95
Advances in Intelligent Systems and Computing	60	65	1.08
Communications in Computer and Information Science	57	97	1.70
Journal of Physics Conference Series	44	51	1.16
International Journal of Emerging Technologies in Learning	40	265	6.63
Lecture Notes in Networks and Systems	33	33	1.00
Education and Information Technologies	31	277	8.94

D. Most Productive Institutions

There are 5091 institutions from all over the world. The Open University (UK) is the most productive organization in the top 10. The second position is the Massachusetts Institute of Technology (US) with 30 papers, followed by Universidad Nacional de Educacion a Distancia (27), and the University of Melbourne (22). In Table IV, it can be seen that the US contributed 3 institutes with a total of 69 articles. In addition, the Open University (UK) is the most cited institution in the field, followed by Stanford University (US) and the Massachusetts Institute of Technology (US). All institutions are located in Europe, Australia, Asia, or the Americas.

TABLE IV: TOP 10 MOST PRODUCTIVE INSTITUTIONS

Institution	Country	A	C	C/A
The Open University	UK	33	1369	41.48
Massachusetts Institute of Technology	US	30	722	24.07
Universidad Nacional de Educacion a Distancia	Spain	27	332	12.30
University of Melbourne	Australia	22	380	17.27
University of Tasmania	Australia	21	235	11.19
Georgia Institute of Technology	US	21	213	10.14
University of Southampton	UK	20	219	10.95
Universidad Carlos III de Madrid	Spain	19	169	8.89
Beijing Normal University	China	19	33	1.74
Stanford University	US	18	495	27.50

E. Most Productive Countries

As for the countries, authors from 103 different countries contribute to the MOOCs literature. A total of 54.37% (*n*=56) countries contributed to at least 10 documents and 38 (36.89%) countries contributed only to one document. Table V lists the top 10 countries/regions in this area. The number of publications from the top 10 countries accounted for 71.51% of the whole data set. As can be seen, China ranks first with 609 publications, followed by the US (478), the UK (230), and Spain (216). The four countries together account for 47.89% of the total publications, reflecting their prominent position in this area. The table includes 5 European countries, 3 Asian countries, 1 North American country, and 1 Oceania country. There are no countries from Africa on the list. In addition, the UK shows good performance in terms of frequently cited papers, followed by the US, Australia, and Germany.

TABLE V: TOP 10 MOST PRODUCTIVE COUNTRIES

Country	A	%	C	C/A
China	609	19.03	1918	3.15
US	478	14.93	6850	14.33
UK	230	7.19	4812	20.92
Spain	216	6.75	2162	10.01
Australia	169	5.28	2256	13.35
India	159	4.97	757	4.76
Malaysia	122	3.81	886	7.26
Russian Federation	120	3.75	549	4.58
Germany	108	3.37	1335	12.36
Italy	78	2.44	409	5.24

F. Most Prominent Authors

The top 10 most productive authors of MOOC publications from 2012 to 2022 are presented in Table VI. D. Andone and D. Burgos are seen as the most active authors with 14 and 12 publications, respectively. Both authors are seen to be the leaders in MOOCs publications so far. C. Alario-Hoyos, L. Chen, C. Meinel, M. Pérez-Sanagustín, S. White, and Q. Zheng are in third place with 8 articles each, indicating their active role in the field. As shown in the table, most highly cited documents were written by authors from western countries/regions. Unfortunately, there are no documents by authors from the US which is one of the top three productive countries.

TABLE VI: TOP 10 MOST PROMINENT AUTHORS

Author	Affiliation	Country	A	C	C/A
Andone, D.	Universitatea Politehnica Timisoara	Romania	14	65	4.64
Burgos, D.	International University of La Rioja	Spain	12	25	2.08
Alario-Hoyos, C.	Universidad Carlos III de Madrid	Spain	9	127	14.11
Chen, L.	Beijing Normal University	China	9	11	1.22
Meinel, C.	Hasso Plattner Institute	Germany	9	162	18.00
Pérez-Sanagustín, M.	Pontificia Universidad Católica de Chile	Chile	9	115	12.78
White, S.	University of Southampton	UK	9	150	16.67
Zheng, Q.	Xi'an Jiaotong University	China	9	11	1.22
Dalipi, F.	Linnaeus	Sweden	8	126	15.75

	University				
García-Peñalvo, F.J.	Universidad de Salamanca	Spain	8	272	34.00

G. Co-Authorship for Authors and Countries

To create a map showing the amount of collaboration between authors, co-authorship network analysis was selected. The co-authorship analysis represents two authors contributing to a joint publication [27]. In this study, the minimum number of documents of an author was adjusted to 2 and the minimum number of citations of an author was stated as 5. Out of 6832 authors, 969 authors met the thresholds. Of these 969 authors, 318 were well connected to form 25 groups. Fig. 3 depicts the entire collaboration network of 318 authors. It should be noted that each node represents one author. The size of the node demonstrates the number of documents published by the author. The larger the node size, the more documents are published by the author [27]. The cluster demonstrating the first group (red; *n*=26) of authors included, for example, Donald C. (2 documents, 4 TLS), Giacaman N. (2, 4), and Orsini-Jones M. (2, 4). The blue cluster consisted of 21 authors, for example, Brooks C. (4 documents, 7 TLS), Williams J.J (4, 1), de Vries P. (3, 9), and Joyner D.A. (3, 2). The cyan cluster is comprised of 15 authors, led by Reich J. (6, 23), Ruiperez-Valiente J.A. (6, 19), and Despujol I. (5, 18). The Spanish author Carlos Alario-Hoyos from the Universidad Carlos III de Madrid appears in the chocolate cluster as one of the authors mentioned most often, in addition to other names such as German professor Christoph Meinel from Hasso Plattner Institute and Chilean author María Pérez-Sanagustín from Pontificia Universidad Católica de Chile. In terms of the total co-authorship strength of one author with the other, it was found that King C. has the highest total link strength (TLS=29) with 6 documents and 107 citations, followed by Robinson A. (27, 5, 104), and Vickers J. (27, 5, 104). It indicates that there is a strong collaboration network among them.

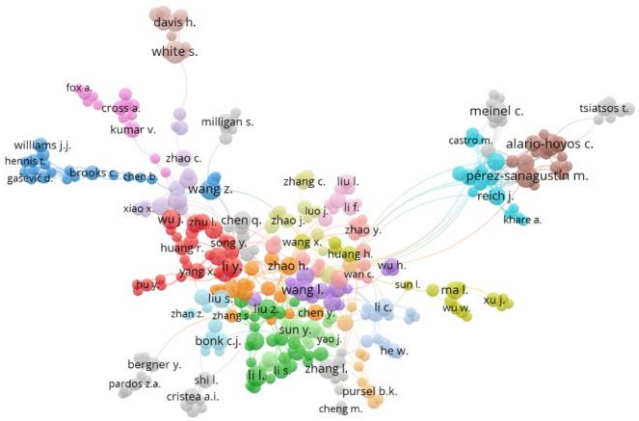

Fig. 3. The visualization network of the author co-authorship.

Then, we conduct an analysis of country co-authorship. Once we set the minimum number of documents of a country as 2 and the minimum number of citations of a country as 5, there are 94 countries/regions that meet the requirements. All these countries (out of 103) are divided into 13 clusters and cooperate with each other. Using VOSviewer, a map of the co-authorship network is presented in Fig. 4. First, in the red cluster (*n*=14), there is a clear collaboration between Russian Federation (with 120 publications and 23 TLS) and Belgium (27, 25); second, in the green cluster (*n*=12), we see the collaboration between Spain (216, 137), France (49, 48), and Mexico (29, 18). Germany, Taiwan, and Switzerland belong to the blue cluster (*n*=10). Australia, Austria, and Ireland belong to the purple cluster (*n*=8). China, the US, and Turkey belong to the cyan cluster (*n*=8). As can be seen, China, the US, the UK, Spain, and Australia are the largest nodes, indicating the productivity of the countries. Therefore, it can be concluded that these five countries are considered the leading countries in the publication of MOOCs.

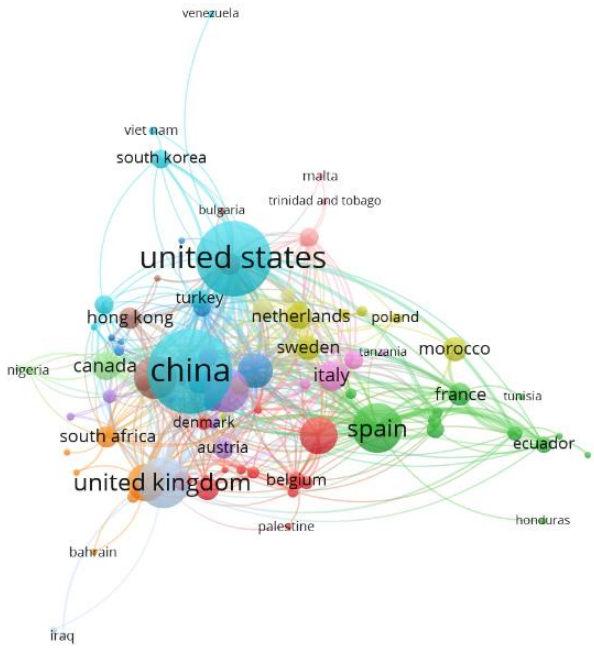

Fig. 4. The visualization network of the country co-authorship.

H. Co-occurrence of Author Keywords

To create a map showing the words used most in the titles, abstracts, and keywords, co-occurrence of author keywords analysis was chosen. To generate keyword co-occurrence network, we used VOSviewer. Co-occurrence analysis represents the occurrence of an author keyword in a particular article [27]. The minimum number of occurrences of a keyword is set to 5 and 261 keywords meet the threshold. An overlay visualization map of author keywords is then presented in Fig. 5.

Looking at Fig. 5, the analysis demonstrates the occurrence (Occ) of 5786 keywords. The most frequent keywords by cluster are: *MOOC* (red cluster), *distance learning* (green), *higher education* (blue), *motivation* (yellow), and *blended learning* (purple). These results suggest that distance learning, motivation, and blended learning in higher education are aspects that are frequently examined in MOOC-related studies. Specifically, the most frequently encountered keywords were *MOOC* (804 occurrences, 1386 TLS), *MOOCs* (569, 1010), and *higher education* (309, 752). As listed in Table VII, the top 10 keywords represent about 46.46% of the total number of author keywords in the analyzed articles. This reveals that all these keywords are popular keywords pertaining to MOOCs in higher education. In addition, the most recent author

keywords were *COVID-19*, *machine learning*, *artificial intelligence*, *blended teaching*, and *deep learning*. This shows that MOOCs have been frequently used in education and training during the COVID-19 pandemic in many countries.

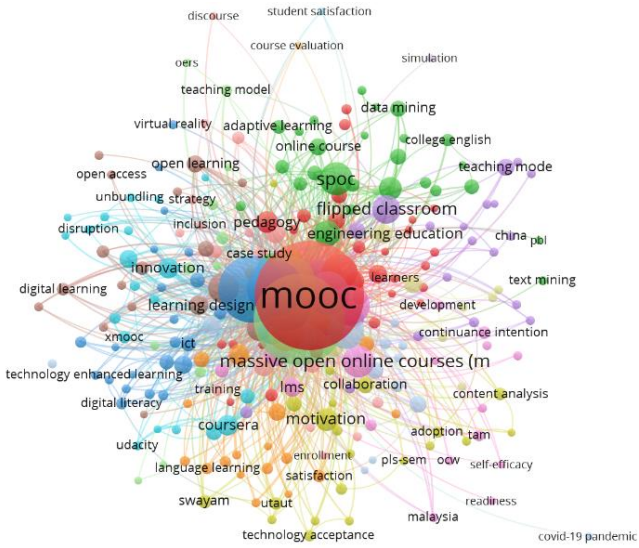

Fig. 5. Co-Keyword network visualization.

TABLE VII: MOST FREQUENTLY USED KEYWORDS

#	Author Keywords	Occ	TLS
1	MOOC	804	1386
2	MOOCs	569	1010
3	Higher Education	309	752
4	E-learning	213	498
5	Massive Open Online Courses	188	411
6	Online Learning	183	460
7	Blended Learning	131	299
8	Massive Open Online Course	109	214
9	Online Education	95	208
10	Learning Analytics	87	207

IV. DISCUSSION AND CONCLUSIONS

This study examined research trends related to MOOCs in the context of higher education up to 2022 through bibliometric analysis. There were 3201 documents retrieved from the Scopus database and then the VOSviewer software was employed for further analysis. Starting in 2012, papers related to MOOCs increased sharply with the highest publication interest in 2021. The year 2021 recorded the highest number of publications with 463 articles or equivalent to 14.46%. The growth trend of annual publications in the current study, reflecting the evolution of the number of documents published each year, complies with the Price law [38]. This indicates that there is a tendency to increase the number of publications, which reflects the growing interest in research in this area. This finding was compatible with that reported by Al-Rahmi *et al*. [17], Liu *et al*. [7], and Sezgin and Cirak [4]. In addition, there has been a sharp increase in the number of citations, particularly from 2012 to 2014. The highest number of citations was observed in 2014 and then relatively started to decline since that year. The downward trend in the number of citations is reasonable because older papers usually have more time to accumulate citations [39].

In terms of highly cited documents, Liyanagunawardena *et al*. [28] publication is the leading document and has the highest citation, with 48 counts out of 656. In a systematic study, they reviewed 45 peer-reviewed papers from 5 databases (2008-2012) and found that there is increasing interest in MOOCs among researchers. A paper by Jordan [29] was cited 38 times out of the total (5.7%). In this article, she analyzed the factors that influence MOOC enrollment and completion and provided a more detailed view of trends in total enrollment and completion rates in the field. The other paper in the top ten citations was published by Hone and El Said [31] and was cited 33 times, which is 5% of the total citations. Hone and El Said [31] conducted a survey of 379 participants in Egypt and explored the factors which affect learner retention within MOOCs. As a result, they reported that there were no significant differences in completion rates by gender, level of study, or MOOC platform. This shows that these three MOOC papers are of high quality and have a significant impact in this area. In the literature, citation has been considered an indicator of quality. For example, high-quality papers were found to be cited more frequently [40]. Thus, this is a possible reason behind this result. Our findings are consistent with the previous studies (e.g. [41]).

Concerning leading productive sources, the *ACM International Conference Proceeding Series* (ACM-ICPS) ranked first with 136 documents. A possible reason for the high volume of publications of ACM-ICPS may be that it publishes content for conferences, technical symposiums, and workshops from the international computing community since 2002. It was followed by the *Lecture Notes in Computer Science including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics* (110) and *CEUR Workshop Proceedings* (78). The top 10 sources with the highest publications are published mostly in European (two-thirds) and North American institutions. Regarding the average citations per article, it was found that the *International Review of Research in Open and Distance Learning* (IRRODL) was in the first position. IRRODL, based in Canada, is a prestigious peer-reviewed journal disseminating original research, theory, and best practice related to open and distributed learning. It was followed by *Education and Information Technologies* and the *International Journal of Emerging Technologies in Learning*, indicating that these three journals have had a significant impact on MOOC studies. When analyzed further, we found that these three journals are in the best quartile; Q1, which indicates high-ranking journals in this area. The high average number of citations may be due to the fact that higher-ranked scientific journals are more frequently read and cited than others [42]. The current findings corroborate the findings of López-Meneses *et al*. [12].

With regard to academic institutions, The Open University is the most productive organization in terms of the number of documents (i.e. 33 publications, 1.03% out of the total). It was followed by the Massachusetts Institute of Technology and Universidad Nacional de Educacion a Distancia (Spain) in second and third place with 30 and 27 publications, respectively. Interestingly, the institution with the highest number of publications and citations is The Open University (located in the UK). While all other universities with 22 papers or less. Although there are not many documents

published by other institutions, it seems that they published a similar number of documents. Regarding country, three of the top 10 most prominent universities in MOOCs are located in the US. The study is convergent with previous studies [7], [41], [43]. In a bibliometric review, Ivanović and Ho [44] also found that the US, its institutions, and journals are top leaders in the Education and Educational Research category.

With respect to leading countries, we found that China (609 publications), the US (478), and the UK (230) have been among the top three countries in most publications over the last ten years. With regard to the highest citation, the US, UK, and Spain are the most influential countries in the field of MOOCs. In other words, these countries can be seen as pioneers in the field of MOOCs. This may be due to the fact that these countries have reputable publishers (e.g. US-based Springer and UK-based Elsevier). Another possible reason is the interest of these countries in research related to MOOCs and their interest in publishing documents in the Scopus database. In addition, countries such as the US and UK have a long past in scientific publishing and have more research resources than developing countries [22]. Similar findings have also been made in previous studies [12, 41]. Based on co-authorship of countries analysis, it was found that the US has the most affiliations with other countries/regions, with 47 linkages and a TLS of 170. It was followed by the UK (links: 44, TLS: 127) and Spain (links: 42, TLS: 136). This implies there is a lot of collaboration between the three countries with other countries. The possible reason is that adequate technology infrastructure and internet access, and availability of resources in these countries may be some of the essential factors supporting research on MOOCs [45].

Regarding influential authors, Diana Andone, from the Universitatea Politehnica Timisoara (Romania), is the highest-ranked author with 14 publications and 65 citations. Daniel Burgos, from the International University of La Rioja (Spain), is the second most productive author with 12 publications and 25 citations. It was followed by Carlos Alario-Hoyos, professor at the Universidad Carlos III de Madrid. The remaining seven authors in the top 10 published 8 to 9 papers. In other words, there is no significance in terms of author activity in the top 10 authors. According to our results, Francisco García-Peñalvo, Christoph Meinel, and Su White appear to be the authors with more citations per paper. In addition, the average number of citations of the top ten authors is 11.08 counts. This finding is not surprising as they are the most prominent authors in the MOOCs literature. This is similar to what was found by Wahid *et al*. [41], who reported that C. Alario-Hoyos, C. Meinel, and M. Pérez-Sanagustín were the top three most prolific authors on this topic. We then performed the analysis of author co-authorship in order to investigate whether there was a collaboration between scholars within the MOOCs research community [27]. The results of the analysis show that there are 25 distinct clusters, consisting of 6 to 26 authors in each group. It can be concluded that there has been a lot of international collaboration within the scientific community on MOOCs research to date.

In this study, co-word analysis was also used to reveal the pattern of co-occurrence in the analyzed articles. This type of analysis is based on the assumption that words "that frequently appear together have a thematic relationship with one another" [21]. Based on the results, the co-word analysis gave rise to sixteen main clusters. These clusters are closely related to all other clusters. The findings suggest that some of the identified keywords with top occurrences are *MOOC*, *MOOCs*, and *higher education*. Since MOOC is a learning program that has been widely accepted in many higher education institutions, it is clear that these variables often appear together in the analyzed papers. This is confirmed by Zancanaro and Souza Domingues [43], who emphasized that the most frequently used terms were *MOOC* (130 repetitions) and *Massive Open Online Course* (70 repetitions).

Over the past decade, MOOCs have exerted a significant influence on adult learning. This may be due to the fact that many participants expressed that learning through MOOC provided the experience and motivated them. Indeed, MOOCs offer an open online course experience that allows participants from different countries to join universities around the world [46]. Due to the rapid growth of MOOCs, colleges and universities across the country are investing heavily in MOOCs to support teaching and learning processes, provide learning experiences, and improve student performance [47, 48].

In the current study, learning analytics also appears as a keyword that is often used in the analyzed articles. Learning analytics is typically used to understand participant learning behavior based on big data. Thus, studies related to MOOCs and learning analytics are interrelated. It should be noted that in addition to having a significant impact on educational research, MOOCs have challenges that need to be addressed, such as low interaction, high dropout rates, and difficult assessment practices at the end of MOOCs [49, 50]. By using learning analytics in MOOC practice, for example, paying attention to the number of comments and views and time spent on viewing materials [51], researchers and educators are expected to be able to overcome problems related to MOOCs. Thus, there is an urgent need for studies that evaluate the potential use of learning analytics to enhance learning design in MOOCs. It aims to promote quality MOOCs that can elevate students' learning experiences and their learning intentions.

In addition, the keyword that appears frequently in recent publications is COVID-19. This may be due to the fact that MOOCs have inspired millions of people to expand their higher education options and improve the quality of their teaching and learning during the COVID-19 pandemic [52, 53]. Accordingly, future studies analyzing changing behavioral patterns of MOOC instructors, participants, and providers will provide valuable information. This means that COVID-19 provides a new direction for MOOC researchers to explore students' learning behaviors and understand their engagement and success.

V. Limitations

The current study offers a comprehensive review of publications related to MOOCs during 2012-2022, using bibliometric analysis. There has been significant growth in the publication of MOOCs over the last ten years, indicating a high level of research interest in the field. However, several

limitations of the current study should be taken into account. First, it should be noted that the findings were from a single database, namely Scopus. Our findings can be extended using other well-known scientific databases such as WoS. Future studies could also combine the documents from different academic databases. Then, non-English papers should also be considered for further bibliometric analysis in order to obtain a more holistic picture of MOOCs. Nevertheless, the results of the current study provide valuable information to enhance researchers' and educators' understanding of current trends and patterns in the MOOC literature. Therefore, this article is relevant for educators, researchers, and practitioners in the field of MOOCs.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

I. Irwanto conducted the research and wrote the paper. D. Wahyudiati and A. D. Saputro analyzed the data, and I. R. Lukman reviewed and finalized the paper. All the authors had approved the final version.

REFERENCES

[1] L. Johnson, S. Adams Becker, M. Cummins, A. Freeman, D. Ifenthaler, and N. Vardaxis, "Technology outlook for Australian tertiary education 2013-2018: An NMC horizon project regional analysis," *The New Media Consortium*, 2013.

[2] S. Downes, "Places to go: Connectivism & connective knowledge," *Innovate: Journal of Online Education*, vol. 5, no. 1, pp. 1-6, 2008.

[3] A. McAuley, B. Stewart, G. Siemens, and D. Cormier, "The MOOC model for digital practice," University of Prince Edward Island, 2010.

[4] S. Sezgin and N. Sevim Cirak, "The role of MOOCs in engineering education: An exploratory systematic review of peer-reviewed literature," *Computer Applications in Engineering Education*, vol. 29, no. 4, pp. 950-968, 2021.

[5] M. Zhu, A. R. Sari, and M. M. Lee, "A comprehensive systematic review of MOOC research: Research techniques, topics, and trends from 2009 to 2019," *Educational Technology Research and Development*, vol. 68, pp. 1685-1710, 2020.

[6] D. Jansen and R. Schuwer. (2015). Institutional MOOC strategies in Europe: Status report based on a mapping survey conducted in October-December 2014. EADTU. [Online]. Available: https://www.surfspace.nl/media/bijlagen/artikel-1763-22974efd1d43f52aa98e0ba04f14c9f3.pdf

[7] C. Liu, D. Zou, X. Chen, H. Xie, and W. H. Chan, "A bibliometric review on latent topics and trends of the empirical MOOC literature (2008-2019)," *Asia Pacific Education Review*, vol. 22, no. 3, pp. 515-534, 2021.

[8] G. Siemens, "Connectivism: A learning theory for the digital age," *International Journal of Instructional Technology and Distance Learning*, vol. 2, no. 1, pp. 3-10, 2005.

[9] M. Aparicio, T. Oliveira, F. Bacao, and M. Painho, "Gamification: A key determinant of massive open online course (MOOC) success," *Information & Management*, vol. 56, no. 1, pp. 39-54, 2019.

[10] R. Deng and P. Benckendorf, "What are the key themes associated with the positive learning experience in MOOCs? An empirical investigation of learners' ratings and reviews," *International Journal of Educational Technology in Higher Education*, vol. 18, no. 1, pp. 1-28, 2021.

[11] R. Mota and D. Scott, *Education for Innovation and Independent Learning*, Elsevier, 2014.

[12] E. López-Meneses, E. Vázquez-Cano, and P. Román-Graván, "Analysis and implications of the impact of MOOC movement in the scientific community: JCR and Scopus (2010-13)," *Comunicar*, vol. 44, pp. 73-80, 2015.

[13] S. Taneja and A. Goel, "MOOC providers and their strategies," *International Journal of Computer Science and Mobile Computing*, vol. 3, no. 5, pp. 222-228, 2014.

[14] S. L. Watson, W. R. Watson, J. H. Yu, H. Alamri, and C. Mueller, "Learner profiles of attitudinal learning in a MOOC: An explanatory sequential mixed methods study," *Computers & Education*, vol. 114, pp. 274-285, 2017.

[15] A. Goli, P. K. Chintagunta, and S. Sriram, "EXPRESS: Effects of payment on user engagement in online courses," *Journal of Marketing Research*, vol. 59, no. 1, pp. 11-34, 2021.

[16] D. Shah. (2021). *By the Numbers: MOOCS in 2021*. [Online]. Available: https://www.classcentral.com/report/mooc-stats-2021/

[17] W. Al-Rahmi, A. Aldraiweesh, N. Yahaya, Y. Bin Kamin, and A. M. Zeki, "Massive open online courses (MOOCs): Data on higher education," *Data in Brief*, vol. 22, pp. 118-125, 2018.

[18] G. Veletsianos and P. Shepherdson, "A systematic analysis and synthesis of the empirical MOOC literature published in 2013-2015," *The International Review of Research in Open and Distributed Learning*, vol. 17, no. 2, pp. 198-221, 2016.

[19] M. Zhu, A. R. Sari, and M. M. Lee, "A comprehensive systematic review of MOOC research: Research techniques, topics, and trends from 2009 to 2019," *Educational Technology Research and Development*, vol. 68, pp. 1685-1710, 2020.

[20] M. P. Modise, "The potentiality of MOOCs as a tool for widening access to higher education in the African context: A systematic review," *International Journal of Learning, Teaching and Educational Research*, vol. 21, no. 5, pp. 84-103, 2022.

[21] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W. M. Lim, "How to conduct a bibliometric analysis: An overview and guidelines," *Journal of Business Research*, vol. 133, pp. 285-296, 2021.

[22] P. Mongeon and A. Paul-Hus, "The journal coverage of Web of Science and Scopus: A comparative analysis," *Scientometrics*, vol. 106, no. 1, pp. 213-228, 2016.

[23] Elsevier. (2022). *Scopus: Your Brilliance, Connected*. [Online]. Available: https://www.elsevier.com/__data/assets/pdf_file/0017/114533/Scopus-fact-sheet-2022_WEB.pdf

[24] I. Zupic and T. Čater, "Bibliometric methods in management and organization," *Organizational Research Methods*, vol. 18, no. 3, pp. 429-472, 2014.

[25] N. A. Ghani, P.-C. Teo, T. C. F. Ho, L. S. Choo, B. W. Y. Kelana, S. Adam, and M. K. Ramliy, "Bibliometric analysis of global research trends on higher education internationalization using Scopus database: Towards sustainability of higher education institutions," *Sustainability*, vol. 14, pp. 1-15, 2022.

[26] D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman, "Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement," *BMJ*, vol. 339, pp. 332-336, 2009.

[27] N. J. van Eck and L. Waltman, "VOSviewer manual," Leiden University, 2021.

[28] T. R. Liyanagunawardena, A. A. Adams, and S. A. Williams, "MOOCs: A systematic study of the published literature 2008-2012," *International Review of Research in Open and Distributed Learning*, vol. 14, no. 3, pp. 202-227, 2013.

[29] K. Jordan, "Initial trends in enrolment and completion of massive open online courses," *The International Review of Research in Open and Distributed Learning*, vol. 15, no. 1, pp. 133-160, 2014.

[30] K. F. Hew and W. S. Cheung, "Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges," *Educational Research Review*, vol. 12, pp. 45-58, 2014.

[31] K. S. Hone and G. R. El Said, "Exploring the factors affecting MOOC retention: A survey study," *Computers & Education*, vol. 98, pp. 157-168, 2016.

[32] A. M. Kaplan and M. Haenlein, "Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster," *Business Horizons*, vol. 59, no. 4, pp. 441-450, 2016.

[33] A. Littlejohn, N. Hood, C. Milligan, and P. Mustain, "Learning in MOOCs: Motivations and self-regulated learning in MOOCs," *The Internet and Higher Education*, vol. 29, pp. 40-48, 2016.

[34] A. Fox, "From MOOCs to SPOCs," *Communications of the ACM*, vol. 56, no. 12, pp. 38-40, 2013.

[35] F. G. Martin, "Will massive open online courses change how we teach?" *Communications of the ACM*, vol. 55, no. 8, pp. 26-28, 2012.

[36] D. Gasevic, V. Kovanovic, S. Joksimovic, and G. Siemens, "Where is research on massive open online courses headed? A data analysis of the MOOC Research Initiative," *The International Review of Research in Open and Distributed Learning*, vol. 15, no. 5, pp. 134-176, 2014.

[37] N. B. Mehta, A. L. Hull, J. B. Young, and J. K. Stoller, "Just imagine: New paradigms for medical education," *Academic Medicine*, vol. 88, no. 10, pp. 1418-1423, 2013.

[38] D. J. Price, *Little Science, Big Science*, Columbia University Press, 1963.
[39] D. W. Aksnes, L. Langfeldt, and P. Wouters, "Citations, citation indicators, and research quality: An overview of basic concepts and theories," *SAGE Open*, vol. 9, no. 1, pp. 1-7, 2019.
[40] M. Patterson and S. Harris, "The relationship between reviewers' quality-scores and number of citations for papers published in the journal physics in medicine and biology from 2003-2005," *Scientometrics*, vol. 80, no. 2, pp. 343-349, 2009.
[41] R. Wahid, A. Ahmi, and A. F. Alam, "Growth and collaboration in massive open online courses: A bibliometric analysis," *The International Review of Research in Open and Distributed Learning*, vol. 21, no. 4, pp. 292-322, 2020.
[42] D. M. Fages, "Write better, publish better," *Scientometrics*, vol. 122, pp. 1671-1681, 2020.
[43] A. Zancanaro and M. J. C. S. Domingues, "Analysis of the scientific literature on massive open online courses (MOOCs)," *Revista Iberoamericana de Educación a Distancia*, vol. 20, no. 1, pp. 59-80, 2017.
[44] L. Ivanović and Y. S. Ho, "Highly cited articles in the education and educational research category in the social science citation index: A bibliometric analysis," *Educational Review*, vol. 71, no. 3, pp. 277-286, 2019.
[45] L. Ma and C. S. Lee, "Understanding the barriers to the use of MOOCs in a developing country: An innovation resistance perspective," *Journal of Educational Computing Research*, vol. 57, no. 3, pp. 571-590, 2018.
[46] N. Alhazzani, "MOOC's impact on higher education," *Social Sciences & Humanities Open*, vol. 2, no. 1, pp. 1-6, 2020.
[47] S. Sezgin and N. Sevim Cirak, "The role of MOOCs in engineering education: An exploratory systematic review of peer-reviewed literature," *Computer Applications in Engineering Education*, vol. 29, no. 4, pp. 950-968, 2021.
[48] Z. Zaremohzzabieh, S. Roslan, Z. Mohamad, I. A. Ismail, H. A. Jalil, and S. Ahrari, "Influencing factors in MOOCs adoption in higher education: A meta-analytic path analysis," *Sustainability*, vol. 14, pp. 1-21, 2022.
[49] P. J. Billington and M. P. Fronmueller, "MOOCs and the future of higher education," *Journal of Higher Education Theory and Practice*, vol. 13, no. 3/4, pp. 36-43, 2013.
[50] M. Zhu, C. Bonk, and A. Sari, "Massive open online course instructor motivations, innovations, and designs: Surveys, interviews, and course reviews," *Canadian Journal of Learning and Technology*, vol. 45, no. 1, pp. 1-22, 2019.
[51] N. A. Shukor and Z. Abdullah, "Using learning analytics to improve MOOC instructional design," *International Journal of Emerging Technologies in Learning*, vol. 14, no. 24, pp. 6-17, 2019.
[52] M. M. Alamri, "Investigating students' adoption of MOOCs during COVID-19 pandemic: Students' academic self-efficacy, learning engagement, and learning persistence," *Sustainability*, vol. 14, pp. 1-15, 2022.
[53] R. K. Meet and D. Kala, "Trends and future prospects in MOOC researches: A systematic literature review 2013–2020," *Contemporary Educational Technology*, vol. 13, no. 3, 1-18, 2021.

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