

Mapping the Publications of e-learning during the COVID-19 Pandemic: A Bibliometric Analysis

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ABSTRACT

Since the prevalence of COVID-19, e-learning has become an extensively dominant approach of education among the Universities and institutions. This study was conducted to explore the growth, and global trend of e-learning during the COVID-19 publications and to evaluate them by analyzing various features of the research outputs. The global publications on e-learning and COVID-19, indexed in Web of Science (WOS), were retrieved and analyzed by bibliometric package of R software. There were 491 publications retrieved and then exported in a plain text format to the bibliometric software. The results showed that the publication on the concept of e-learning and COVID-19 started in 2020, increased rapidly after the COVID-19 pandemic, and thereafter has received increasing attention by researchers, particularly in 2021. We found that the USA is the leading country with the highest number of publications followed by India, Spain, Saudi Arabia, Jordan and the UK. Also, the findings show that "Education", followed by "Students", "Impact" and "Model", have the highest frequency among keywords in the literature, indicating that e-learning is a general topic in many fields. Conceptual structure map analysis classified the e-learning and COVID-19 publications into four main clusters. This study aimed to presents a comprehensive scenario of e-learning and COVID-19 publications after the prevalence of the pandemic. The results of this paper, can contribute to the existing knowledge, via showing e-learning and COVID-19 research volumes and trends. The outcome of this paper should be considered by institutions, universities, researchers and librarians.

Keywords: E-learning, COVID-19, Bibliometrics, Mapping, Visualization.

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INTRODUCTION

Electronic learning (e-learning), referring to learning in an electronic and interactive environment, is an innovative method of education in which lectures can have access to educational resources anywhere anytime and provide the learners with an education environment which is friendly, interesting, flexible, and extensive in scope. E-learning yields an opportunity for individuals to become independent learners with the ability to employ their own style of learning, and with the chance to practice lifelong learning.^[1,2]

E-learning, a globally dominant learning platform, has a considerable potential in imparting formal and informal education, in parallel, as a supplement, or an alternative to traditional classroom approach to education. It has extended learning beyond physical classrooms, removed the

physical boundaries of academic institutions, opened up new opportunities for aspiring learners and workforce, increased global connectivity by facilitating connections across the globe, provided competency-based learning, and revolutionized teaching methods.^[2]

E-learning facilitates learning, by reducing costs, including a large number of learners, promoting teaching materials both in quality and quantity, improving access to a repository of education materials, and creating a clear accountability for all members in the learning process. In today's fast-paced environment, organizations which have adequate investment in the infrastructure required for e-learning, can adapt much better and faster to changes,^[1,2] leading to a significant strength in the organizational continuity. It seems that, e-learning has found its appropriate place in the current education system due to the existence of technological advances, new and innovative approaches to education, and public and organizational policies.

COVID-19 has generated a significant amount of media coverage and scientific publications across the globe. This disease which initiated from China rapidly spread to over 210 countries worldwide, and became a pandemic.^[3] Prior to the prevalence



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of the COVID-19 pandemic, e-learning was covering about 15 percent of the courses yearly without being mandatory for institutions and learners worldwide. Upon the fast expansion of the COVID-19 pandemic, the situation changed, and universities and institutions quickly began offering a major part of their services including lectures, teaching sessions, meetings, etc. online, using new technology platforms.^[4] E-learning has been suggested by many universities and education institutions to fill the created gap in teaching, and to maintain the continuity of education during the pandemic. Therefore, the online learning (e-learning) replaced the traditional face to face teaching.^[5]

Radha *et al.* (2020) has reported that in the lockdown period, due to the geographical separation, and social distancing caused by COVID-19 pandemic, e-learning become quite a popular alternate method of learning among the educational institutions.^[6] Moreover, Almaiah *et al.* (2020) argued that COVID-19 forced universities and education institutions to adopt on-line learning, rapidly. They further added that e-learning had a determining role in the survival of educational institutions during the pandemic, because it has the potential of facilitating teaching and learning, and aiding institutions to continue the daily activities online.^[7]

Electronic content providers, new technology providers, e-learning technology suppliers and reputable online institutions have grown due to the increase in scientific publications in the field of e-learning, leading to the emergence of a large and growing e-learning industry at the national and international levels.^[2]

However, the investigation of the relevant literature on this subject, especially in the COVID-19 pandemic period, is not sufficient. As Tibaná *et al.* (2018) has remarked, despite the dominance of e-learning in various areas, in the COVID-19 pandemic, this theme does not yet exist in the global system of publications.^[8] Moreover, other studies have indicated that the number of the studies conducted in the field of analyzing e-learning publications is not sufficient.^[8-11]

Analyzing research appearing in scientific publications, can be performed by using bibliometric studies. Bibliometrics is the application of mathematical and statistical approaches to measure the publication of a particular field.^[10] Gupta *et al.* (2020) acknowledged that “few studies on the bibliometric/scientometric analysis of e-learning research are available in the literature”.^[2] Thus, this study was conducted to explore the global growth of publications on e-learning during the COVID-19 pandemic, by using bibliometric techniques, and to make quantitative and qualitative assessment by analyzing various features of research outputs such as the annual scientific production, top source local impact, word cloud of e-learning during the COVID-19 publications, word growth during the annual scientific production, trend topic during annual scientific production, thematic map of publication, etc.

METHODOLOGY

This was a cross-sectional and descriptive study conducted on the basis of bibliometric analysis techniques in July 2021. Bibliometrics is an adaptable and applicable strategy dealing with the nature and the way data is displayed quantitatively. Bibliometrics could be used in assessing, blending and examining both published, and non-published data by applying mathematical and statistical methods to measure the research output of scientific publications.^[9]

The global publications on e-learning during the COVID-19 pandemic, indexed in Web of Science (WOS), were retrieved and analyzed by bibliometrix package of R software. We used the keywords of “electronic learning” and “Covid-19” in title, with AND as the Boolean operator with no time limitation for the literature search (1975-2021).

By applying the above search strategy, 491 studies were retrieved, and then exported in plain text format to bibliometrix software. The retrieved data were analyzed for the following bibliometric indicators: 1) annual scientific production, 2) distribution of publications based on countries, 3) top source local impact, 4) leading authors in the field of e-learning during the COVID-19 pandemic, 5) word cloud of e-learning publications during the COVID-19 pandemic, 6) word growth of the annual scientific production, 7) trend topic of annual scientific production, 8) thematic map of publication, and 9) Conceptual Structure Map.

RESULTS

The research output regarding e-learning during the COVID-19 pandemic consisted of 491 publications between 2020 and 2021, with an average of 245 publications per year. Figure 1 shows the growth trend of literature on e-learning. As the Figure presents, the number of publications has been growing gradually since 2020, and the highest number of articles have been indexed in 2021.

Figure 2 demonstrates the distribution of publications based on the corresponding author's country, author's keywords and keywords plus, keywords dedicated by WOS to articles. The Figure shows that the USA is working as the leading country on “e-learning” during “Covid-19” in education. Moreover, India, Spain, Saudi Arabia, Jordan and the UK have shown significant contributions in the research regarding “e-learning”, “Covid-19”, “Impact” and “education”. This Figure shows that issues related to “e-learning”, “Covid-19”, “education”, “pandemic”, and “medical education” are the most frequent topics, followed by “online learning”, “distance learning” and “Coronavirus”, addressed by researchers in majority of countries.

Figure 3 shows the top ten journals according to the source impact. As this Figure shows, the journals with the highest impact in e-learning and COVID-19 literature are “Education

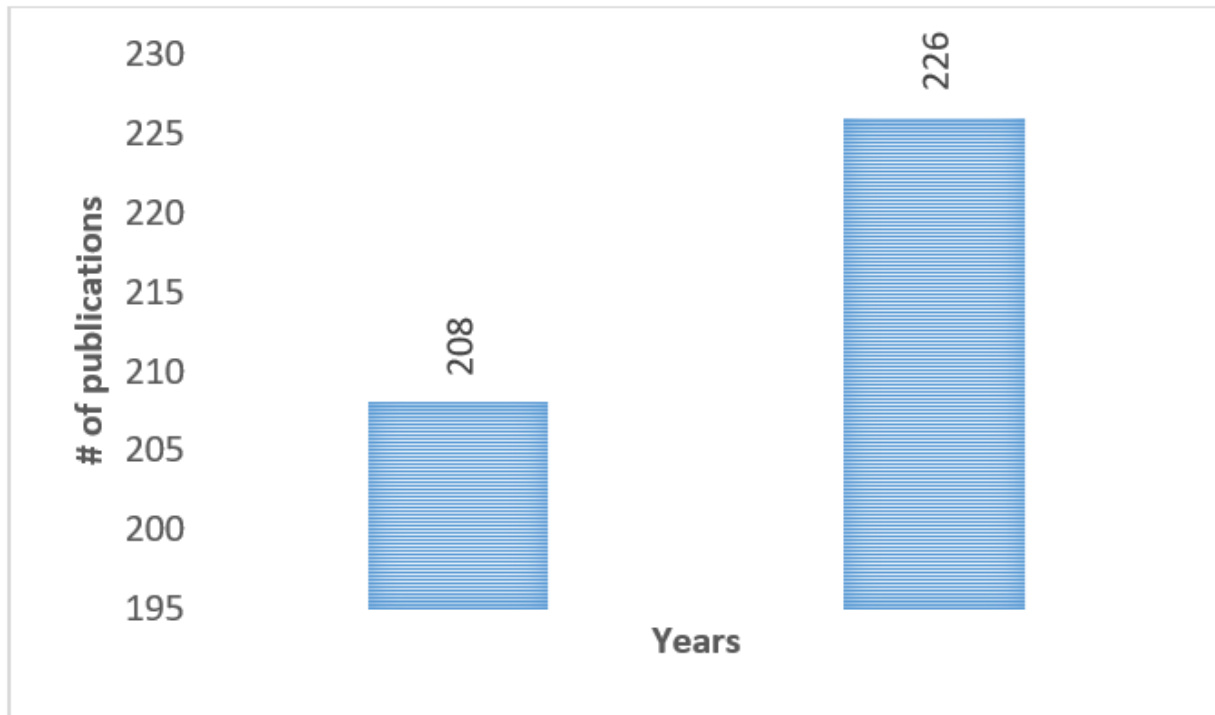


Figure 1: Annual scientific production of e-learning and COVID-19.

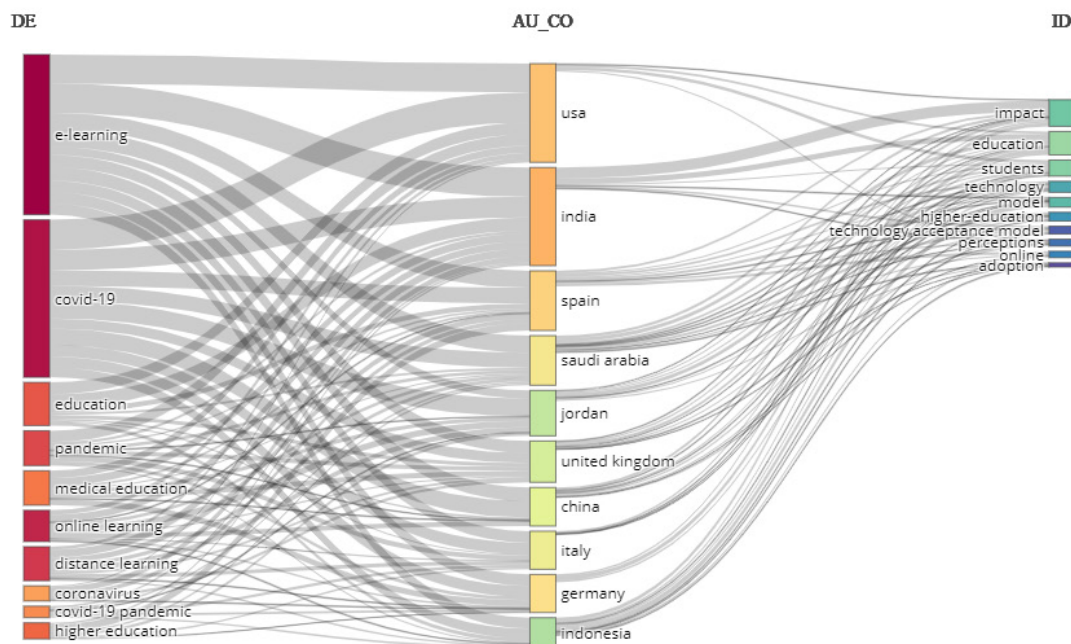


Figure 2: Three-fold analysis of e-learning literature. (Note; ID: Author keywords, AU_ CO: Corresponding Author Country, DE: Keywords Plus).

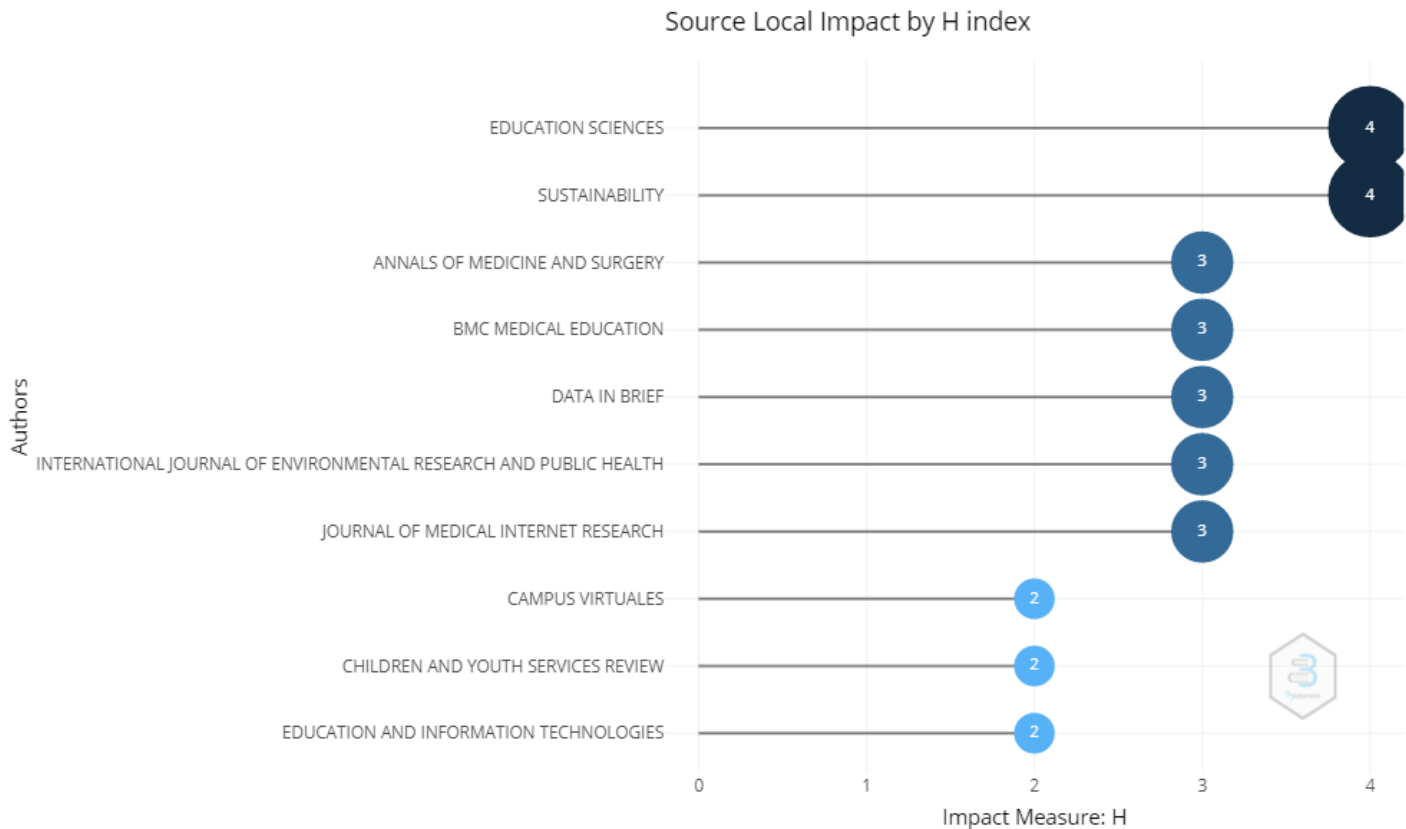


Figure 3: Source Local Impact.

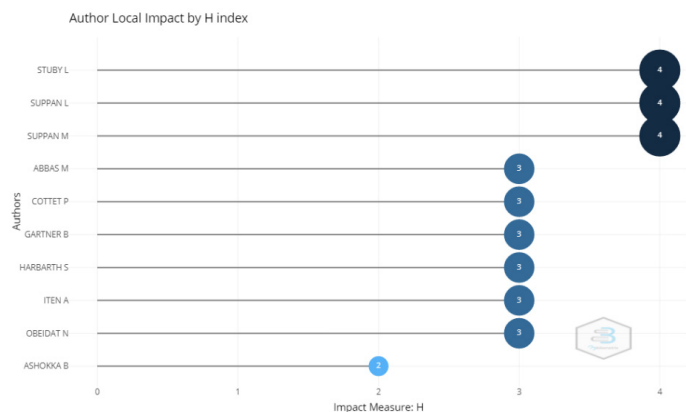


Figure 4: Author's local Impact.

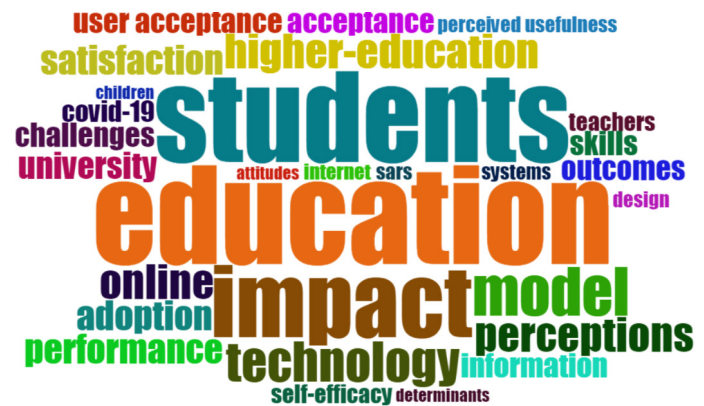


Figure 5: Word cloud of e-learning publications.

Sciences” and “Sustainability”, followed by “Annual of Medicine and Surgery” and “BMC Medical Education”.

Figure 4 shows the top ten authors according to author local impact by *h*-index. As this figure shows, “STUBY, L” and “SUPPAN, L”, followed by “SUPPAN, M” and “ABBAS, M”; have the highest *h*-index, the greatest impact, in the e-learning and the COVID-19 literature.

Figure 5 presents the word cloud made on the basis of authors’ keywords with respect to e-learning during the pandemic. The words appearing in a larger size are higher-frequency words used in the literature. “Education”, followed by “Students”, “Impact”

and “Model” have the highest frequency, followed by “Online”, “Adoption”, “Perception”, “Performance”, “Covid-19”, “Challenges” and “University” which appear with a relatively lower frequency in the literature of e-learning during the COVID-19 publications.

Figure 6 shows the word growth overtime in the e-learning and COVID-19 literature. This Figure shows that the publications with the subject of “Students”, “Impact”, “Education” and “Model”; have shown a significant growth in the literature after the prevalence of the COVID-19 pandemic.

Figure 7 shows the trend topic in e-learning and COVID-19 literature. After the COVID-19 incidence, “Internet”,

Word Growth

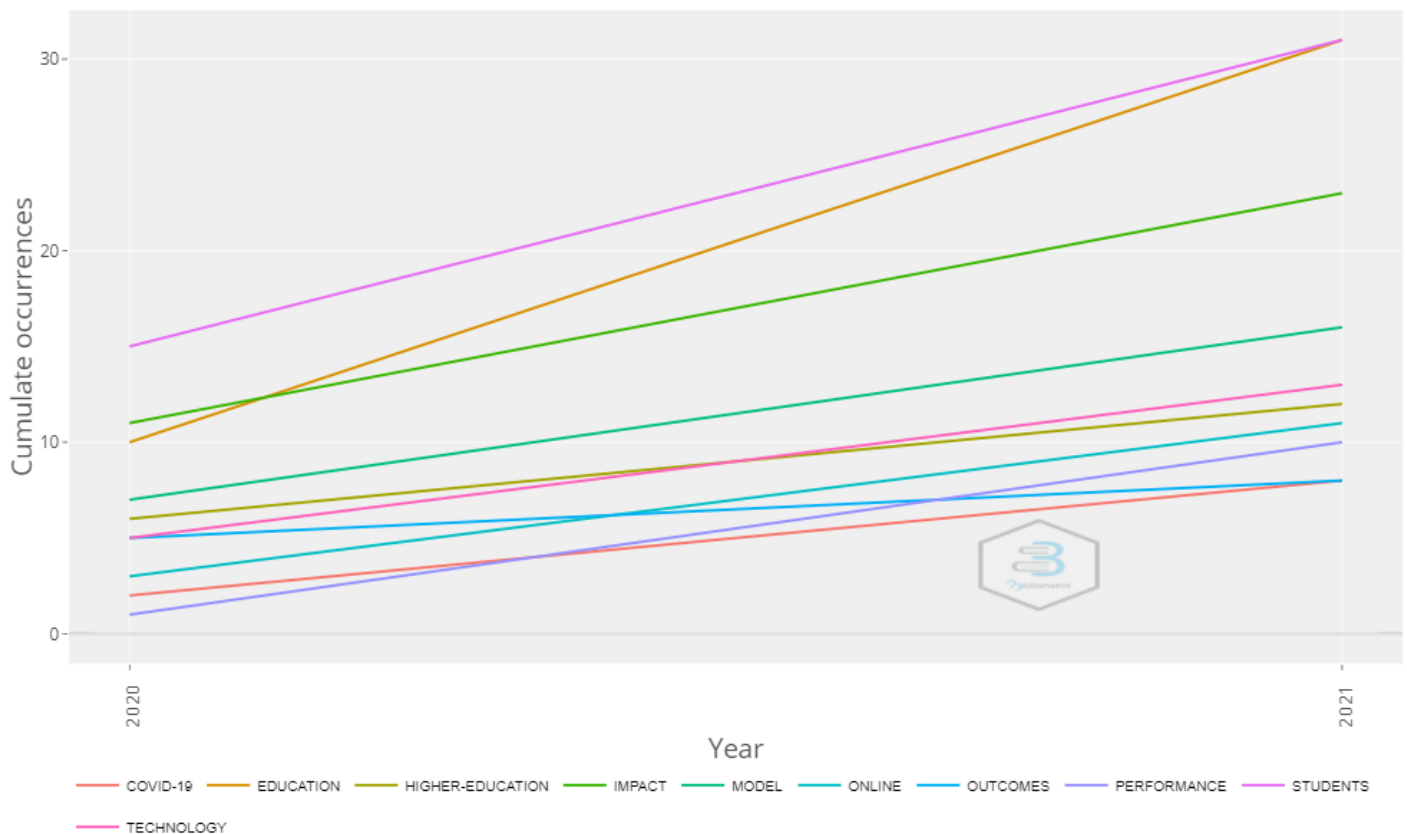


Figure 6: Word Growth in Annual scientific production.

“Information”, “Outcomes”, “Higher Education” and “Technology Acceptance Model”; have been addressed as the main subject of research. As the Figure shows one year after the onset of the pandemic, new concepts such as “Education”, “Students”, “Impact”, and “Model”; have received more attention by researchers.

Figure 8 demonstrate the thematic map of the e-learning and COVID-19 productions. As this Figure shows, the topics related to e-learning and COVID-19 are divided into ten clusters. There is one cluster located in zone 1 (Motor term), showing a high centrality and density, regularly investigated and addressed by researchers. There are also four clusters, “Simulation”, “Antecedents”, “Children” and “Risk”, located in zone 2 (Niche term), with low density and considerable centrality, but low frequency. Four clusters of “education”, “Technology”, “Technology acceptance model” and “Model”; located in zone 3 (basic terms), show high centrality and low density. In zone 4 (emerging terms), there is one cluster with the concept of “college students”.

Figure 9 presents the conceptual structure map of the e-learning and COVID-19 literature based on authors’ keywords. The publication involved in the analysis are classified into four main clusters. Concept such as “information technology”, “virtual learning”, “medical education”, and “technology acceptance

model” are categorized into one cluster; the biggest cluster indicates that these concepts have conceptual associations. Other clusters consist of some related concepts in the e-learning and COVID-19 literature, indicating the association between them. For example, “telehealth”, “telemedicine” and “Social media” are located in one cluster.

DISCUSSION

The current study aimed to investigate the peer-reviewed literature on e-learning during the COVID-19 pandemic in the WOS database by using the bibliometrix software and R package bibliometrix. This study provides the results of a bibliometric analysis of a total of 491 studies on the e-learning and COVID-19 research published between 2020 and 2021.

The results show that the publications on e-learning and COVID-19 started in 2020, rapidly after the incidence of the COVID-19 pandemic, and continued to receive increasing attention by researchers, particularly in 2021 (Figure 1). Limaymanta *et al.* (2021) acknowledged that the publications of flipped classroom shows a sharp peak in 2020, mostly due to researchers’ attention to this topic reflected in the increasing number of studies number on e-learning during the COVID-19 prevalence.^[10] Similarly, Tsai and Wu (2020) reached to the same

Trend Topics

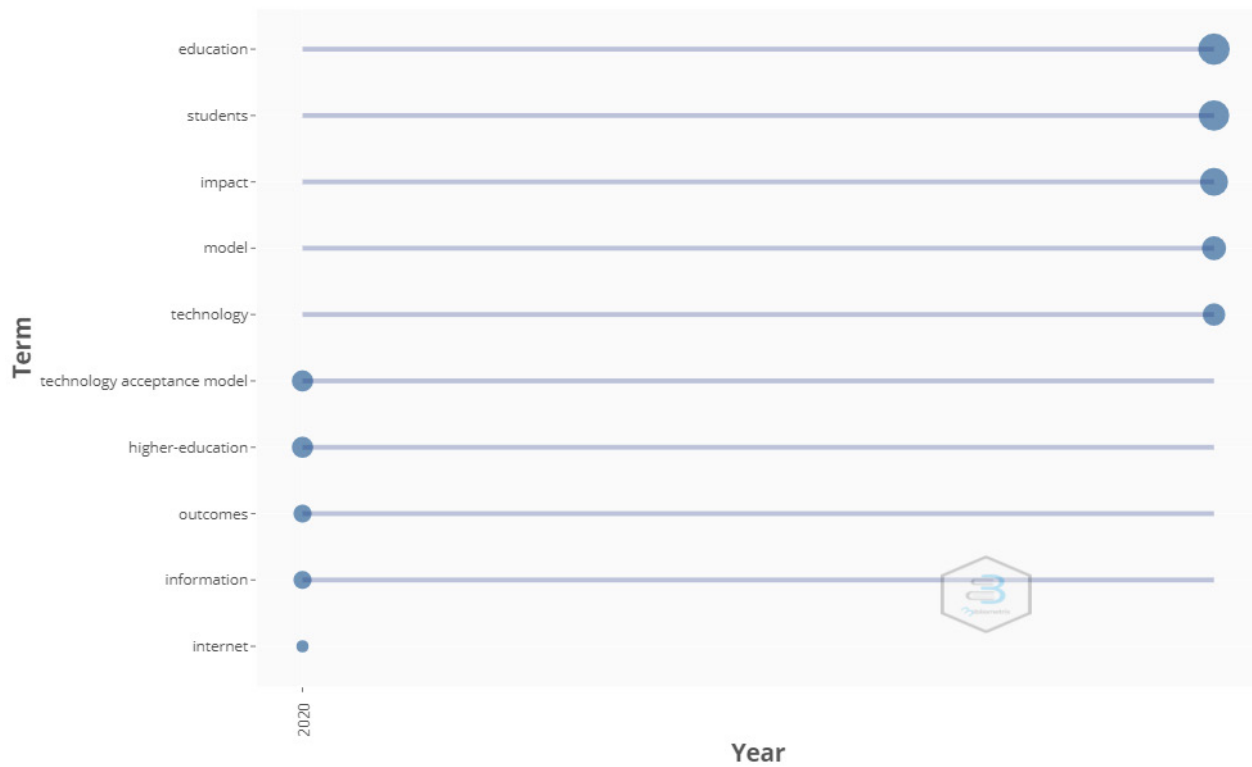


Figure 7: Trend Topic during Annual scientific production.

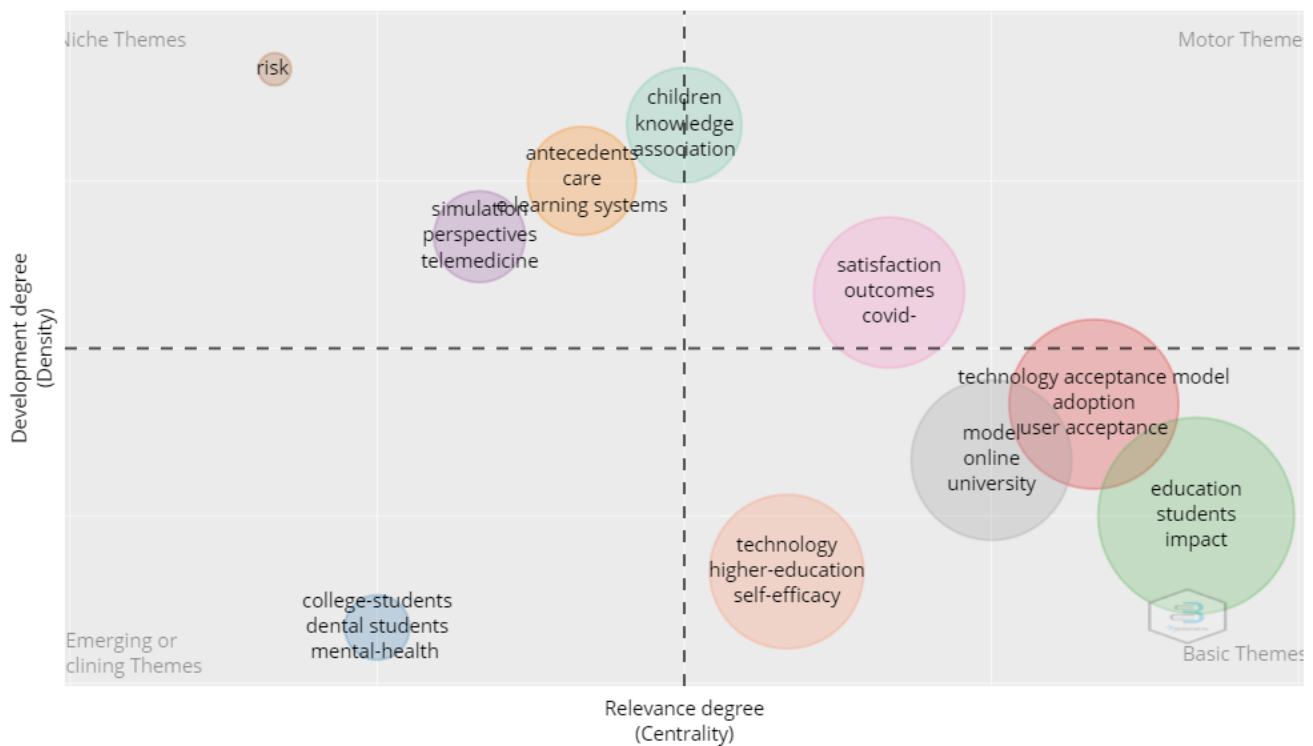


Figure 8: Thematic map of e-learning production.

Conceptual Structure Map - method: MCA

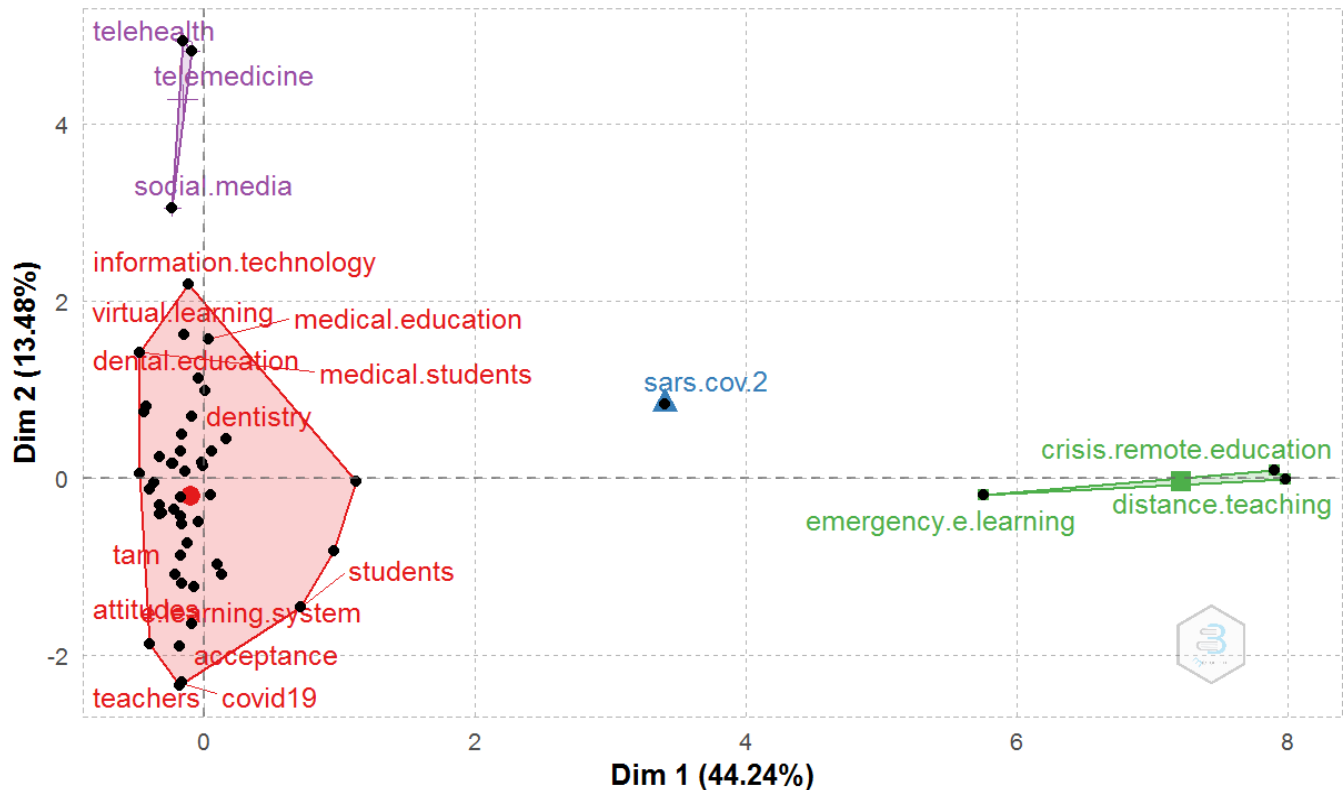


Figure 9: Conceptual Structure Map.

results, and found that the publication on flipped classroom in e-learning context, gradually increased after 2013 and then dramatically increased from 2015 to 2020.^[12] These findings also indicate that e-learning has attracted considerable attention of researchers and, and there will be more focus on this subject in the near future. This suggests that in case of similar disasters such as COVID-19, e-learning can be an alternative and efficient method in education, and that is why institutions and universities are moving forward in this direction worldwide.

Concerning the leading countries in the field of e-learning and COVID-19, the results of this study show that the USA is the leading country with the highest number of publications followed by India, Spain, Saudi Arabia, Jordan and the UK (Figure 2). We also noticed that these countries are working on the subjects of “e-learning”, “Covid-19”, “Impact” and “education”. Similarly, Gupta and Dhawan (2020) found that around two thirds of the e-learning research outputs (62.58%) came from 10 leading countries. The USA with 22.11 percent of publications located in the first rank, followed by Spain and China.^[2] Limaymanta *et al.* (2021) acknowledged that the majority of publications in the field of flipped classroom, were published by top active countries such as the USA and the UK.^[10] An interesting finding in this regard is the presence of developing countries such as India, Saudi Arabia and Jordan among leading countries. Aboagye *et al.* (2021) noticed that developing countries compared to the developed world, experience more challenges such as poor internet, inadequate

knowledge and weakness of e-content development.^[5] While developed countries have a longer history of using e-learning and have already started investing on it, developing countries have a shorter history of using e-learning, and have recently shifted to this approach because of the prevalence of COVID-19, leading to extensive quarantine and shut down of schools. These issues might be responsible for the high number of investigations and publications in developing countries.

Regarding the source local impact by *h*-index, the findings of this study suggest that “Education Sciences” and “Sustainability”, followed by “Annual of Medicine and Surgery” and “BMC Medical Education”; are the four top journals which have shown more impact on e-learning and COVID-19 publications (Figure 3). Fatima and Abu (2019) conducted a bibliometric study on e-learning research studies in WOS, and found that “Computers and Education” journal was the top journal with the highest number of publications.^[9] Similarly, Chen *et al.* (2020) discussed that for over 40 years, “Computer and Education” had been the leading journal in the field of computer in education.^[13] The results of those two studies indicate that, “Computers and Education” had been acknowledged as a source of publication with significant influences on the e-learning and education technologies for more than 40 years. However, upon the prevalence of COVID-19, new journals such as “Education Sciences” have become new sources for e-learning and COVID-19 publications. There is high likelihood of observing this trend among other journals, i.e.,

the publications addressing technology and education may not be limited to a few journals, and other journals would welcome the topic as well. It also shows that the continuity of education is of prime importance to medical education, the research and publications of which are demonstrated in journals such as "Annual of Medicine and Surgery" and "BMC Medical Education".

In terms of high influencing authors, we found that "STUBY, L" and "SUPPAN, L", followed by "SUPPAN, M" and "ABBAS, M"; have the greatest impact in the e-learning and COVID-19 literature (Figure 4). These mentioned authors are affiliated to University of Geneva hospital and Faculty of Medicine, the USA. Another interesting finding show that 1850 authors have contributed to the publication of e-learning during the COVID-19 by just one article, while 59 authors had two articles, and eight authors three articles on the topic, showing the considerable scatter of authors in publishing articles in the field of e-learning and COVID-19.

We found that "Education", followed by "Students", "Impact" and "Model", have the highest frequency in the literature of e-learning during the COVID-19 pandemic. (Figure 5). "Covid-19" and "SARS" were the two words, appearing with high frequency in the word cloud. This finding is partly in line with the finding of Nasir *et al.* (2020) who conducted a bibliometric study in Social Sciences and found that "Humans" and "SARS" had the highest frequency in the publications of social sciences.^[14]

Concerning the word growth during the annual scientific production, the findings show that "Students", "Impact", "Education" and "Model"; are words with significant growth in literature after the prevalence of the COVID-19 pandemic. The findings on word growth analysis show the author's behavioral attention regarding research subjects. With regard to the trend topic in e-learning and COVID-19 literature, we found that after the COVID-19 incidence, at the end of 2019 and the beginning of 2020, "internet", "information", "outcomes", "higher education" and "technology acceptance model"; have been considered as main subjects, but, one year after the pandemic, new concepts such as "Education", "Students", "Impact", and "model" emerged (Figure 7). Trend topic is considered as potential tools used by researchers to show an outlook and comprehensive perspective of the publication trend in specific fields. For example, the trend of publication of e-learning in India was presented in a bibliometric study,^[15] or Chiang *et al.* (2010) examined the trends of e-learning literature in terms of growth rate in SSCI database between 1967-2009.^[16]

The analysis of the thematic map of e-learning and COVID-19 productions, revealed that publications could be divided into ten clusters and four zones based on density (X-axis) and centrality (Y-axis) (Figure 8). "The centrality measures the importance of the selected theme, and density measures the development of the chosen theme."^[14] The data taken from this map show that concepts such as "Education", "Students", and "Impact" (cluster

1), "Technology acceptance model", "Adoption" and "User acceptance" (cluster 2), "model", "online", and "university" (cluster 3, and "technology", "higher education" and "self-efficacy" are the basic themes of e-learning and COVID-19 publications, with a high density and low centrality, indicating that these themes have been developed in the related publications. "Satisfaction", "outcome" and "Covid-19" cluster located in zone 1, motor terms, are shown with both high centrality and density. Four themes located in zone 2 with high centrality and low density are "Children", "Antecedents", "Simulation" and "Risk". Finally, the cluster with low centrality and low density located in zone 4 (emerging themes), indicates these concepts should be more considered by researchers as new and emerging subjects.

Similarly, the literature shows that e-learning is a general topic in many fields such as education, technology, and computer sciences. We noticed that the e-learning and COVID-19 publications are associated with a range of concepts such as "impact", "efficacy", "simulation", and "behavior".^[17,18]

The findings from the conceptual structure map analysis show that e-learning and COVID-19 publications are classified into four main clusters (Figure 9). The placement of concepts in one cluster, indicates their thematic relevance in articles. "Information technology", "virtual learning", "medical education", and "technology acceptance model"; are located in one cluster, the biggest cluster, suggesting that these concepts have conceptual associations. "Telehealth", "telemedicine" and "social media" are categorized into the same cluster. Das (2021) conducted a study entitled "research trends of e-learning: A bibliometric and visualization analysis", and found that "e-learning", "education" and "online learning" were the biggest cluster with a high frequency of publications.^[11]

CONCLUSION

The publication on e-learning and the COVID-19 shows a considerable growth after the COVID-19 pandemic, indicating that it has received significant attention by researchers in some major disciplines. Applying a combination of bibliometric indicators and analysis techniques, we tried to present a comprehensive scenario of e-learning and COVID-19 publications, the volume, and research trend after the pandemic. The findings of the present study which provide deep and valuable insight into the research volume and trend of e-learning during the COVID-19 pandemic can contribute to the existing knowledge, and educational institutions, universities, researchers and librarians can benefit from them.

AUTHORS' CONTRIBUTION

Afsaneh Dehnad: Conceptualization, data analysis, writing, review and editing. Mohammadhiwa Abdekhoda: Conceptualization, literature search, data collection, organization and analysis.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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