Review

COVID 19 and Quality of Education: A Bibliometric Study and Narrative Review

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Review

COVID 19 and Quality of Education: A Bibliometric Study and Narrative Review

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Abstract: In the educational process, quality has long been considered a critical component. It may get impacted due to different factors especially when talking about the COVID19 pandemic. The purpose of this investigation is to explore the impact and relationship between COVID-19 and the quality of education using bibliometric analysis. As face-to-face learning shifts to online learning, this research investigates how the COVID-19 epidemic has affected education quality, concentrating on Programme Educational Outcomes (PEOs), Programme Learning Outcomes (PLOs), and Course Learning Outcomes (CLOs). The research covers pandemic online education, literature, and trends. There are two important steps in any bibliometric analysis selecting keywords and databases. The initial set of keywords was selected by the authors' experience and then an online survey study through Google Forms was conducted among experts in the research area. This was followed by a search of the selected keywords in the databases consisting of PubMed, Web of Science (WoS), and SCOPUS. Therefore, the final data was collected from the SCOPUS database on August 24, 2021. Hence, 182 documents were considered for the current study. The document's data were analysed by using the "visualization of similarities" (VOS) Viewer software and the R-Tool of the Bibliometrix-package that was specifically designed for quantitative Bibliometrics research. Based on the obtained data, the results showed the quality of education that may get impacted by the changing of the education delivery from face-to-face to online-based learning. In conclusion, this study showed the importance of studying the correlation and impact of COVID-19 on the quality of education.

Keywords: publication trends; coronavirus; top papers; highly cited paper; PEO; PLO and CLO

Introduction

In the history of development education, quality has been thought of as a key factor in the education process. However, in the twenty-first century, at the end of 2019, in Wuhan, one of China's high-tech commercial centres, a totally new coronavirus emerged, killing tens of thousands of Chinese residents in the first fifty days of its spread and injuring many more. COVID-2019 expanded internationally later, in a shorter period of time (Shereen et al., 2020). For many sectors throughout the world, the repercussions of a pandemic are irreversible and unpredictable. Moreover, face-to-face teaching has been abandoned in nearly 120 nations, and COVID-19 has impacted the education of roughly a billion of students throughout the world. Further, E-learning is used by the majority of higher education institutions worldwide (Shahzad et al., 2021).

Bibliometrics is a powerful tool to analyze scholarly performance statistically by measuring the number of publications, citations, keywords occurrences, and collaboration networks (Ale Ebrahim et al., 2020). Bibliometric analysis alone cannot be a substitute for qualitative peer assessment (Nordin

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et al., 2019). Therefore, bibliometric results should be used with precautions to evaluate the relevant scholarly outputs (Franceschini & Maisano, 2011). Bibliometric study gives an overview to a specific research area which can be elaborated by qualitative analysis. Using qualitative analysis alongside a bibliometric study will elaborate more insight into scholarly outputs (Farahmand et al., 2018). Therefore, in this study a qualitative study was carried out beside the bibliometric study.

There are many bibliometric studies on COVID 19 (133 out of 175,863 documents). However, a few of them (3 out of 133) emphasize COVID 19 and education. Rodrigues et al. (2020) investigated COVID 19 and disruption in management and education academics. Mustapha et al. (2021) analysed the effectiveness of digital technology in education during COVID 19 pandemic. Finally, Karakose and Demirkol (2021) explore the emerging COVID 19 research trends and in the field of education through a bibliometric study. However, there is not a comprehensive qualitative and quantitative analysis on "COVID 19 and quality of education". Therefore, the current bibliometric study tried to find the trends of publications on "COVID 19 and quality of education" with they're the most influential authors, institutions, countries, and sources and discover the emerging terms of the research area which it shapes the dynamics of future research. Besides quantitative analysis, there is a qualitative analysis for exploring the main key phrases used by the most influential studies. Another purpose of the current bibliometric research was to examine how the COVID-19 pandemic affected educational outcomes, such as Programme Educational Outcomes (PEOs), Programme Learning Outcomes (PLOs), and Course Learning Outcomes (CLOs), during the transition from traditional classroom settings to online learning environments. With the help of bibliometric analysis, this paper summarises the state of the art in the field of online education during pandemics, highlighting key trends and patterns.

Method

There are two important steps in any bibliometric analysis selecting keywords and databases. The initial set of keywords selected by the authors experience and then an online survey study through Google forms conducted among experts in the research area. There were 126 responses out of 150 participants who received the form link via WhatsApp group (refer to appendix 1). Experts had the choice to select from the proposed keywords set and suggest their own preferred keywords. 22 keywords were suggested in the online survey study and the participants of the survey suggested 15 keywords (Figure 1). The responses were analysed to choose the suitable and the most relevant keywords for the current paper. Figure 1 illustrated the suggested keywords. Table 1 shows the most relevant keywords for the COVID19 and quality education topic. The alternative keywords for COVID 19, "Coronavirus", "Corona virus", "2019-nCoV", "SARS-CoV", "MERS-CoV", "Severe Acute Respiratory Syndrome", and "Middle East Respiratory Syndrome" were selected from "COVID 19 Open Research Dataset" (CORD-19) (Wang et al., 2020). The final keywords set in the form of search query were TITLE: (quality AND ("education" OR "learning" OR "teaching" OR "studying")) AND TOPIC: ("COVID-19" OR "Coronavirus" OR "Corona virus" OR "2019-nCoV" OR "SARS-CoV" OR "MERS-CoV" OR "Severe Acute Respiratory Syndrome" OR "Middle East Respiratory Syndrome").

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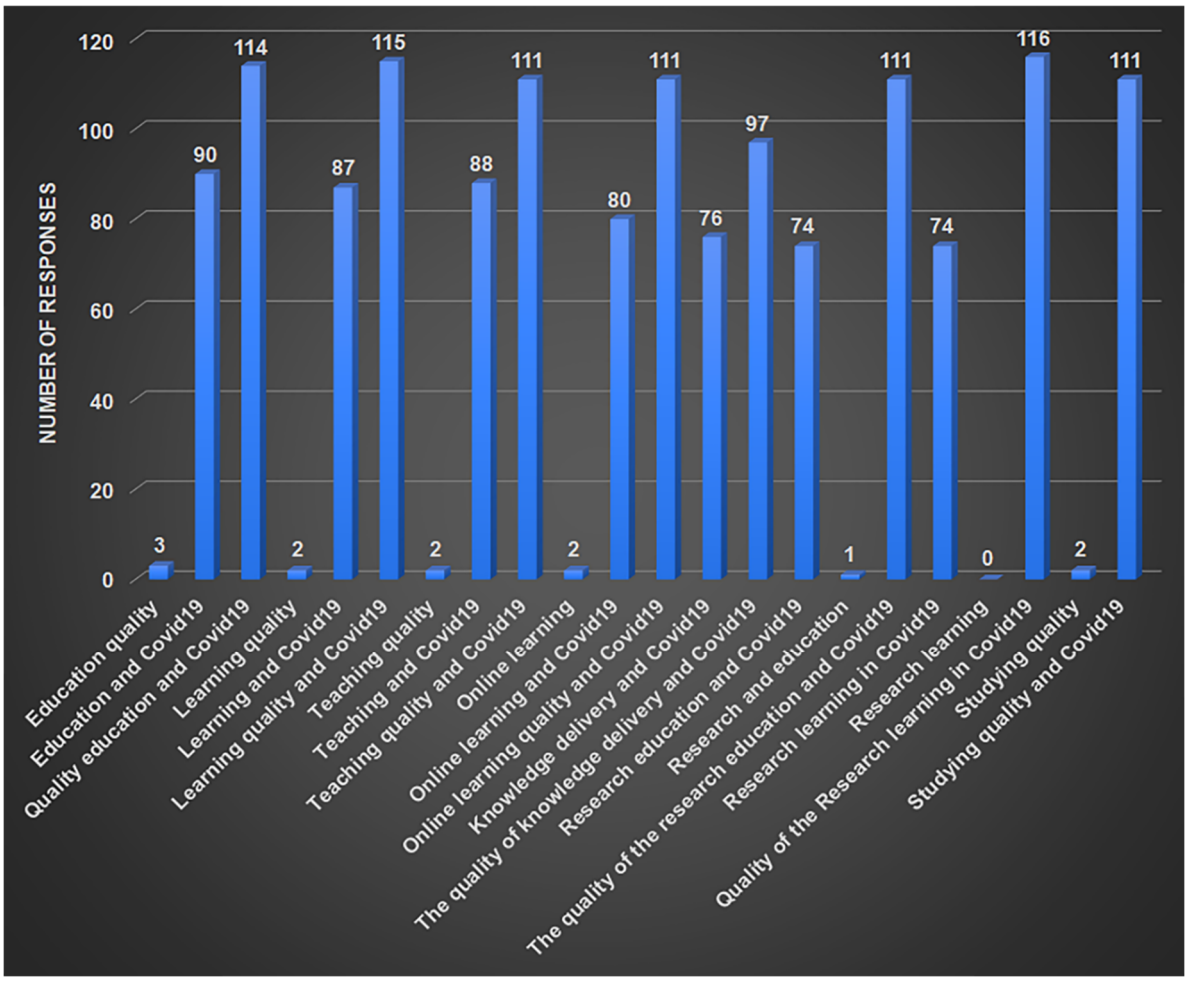

Figure 1. responses and the selection of the keywords suggested in the survey study.

Table 1. The most relevant keywords selected in the survey study for "COVID19 and quality education".

Keywords	Percentage (%)
Quality education and COVID19	90.5
Learning quality and COVID19	91.3
Teaching quality and COVID19	88.1
Online learning quality and COVID19	88.1
The quality of research education and COVID19	88.1
Quality of the research learning and COVID19	92.1
Studying quality and COVID19	88.1

Three databases consisting of PubMed, Web of Science (WoS), and SCOPUS search for the selected keywords set. There were more documents on SCOPUS database compared to PubMed and WoS (Table 2). Therefore, the final data was collected from SCOPUS database on August 24, 2021. Hence, 182 documents were considered for the current study. The documents data were analysed by using the "visualization of similarities" (VOS) Viewer software (Van Eck & Waltman, 2010) and the R-Tool of the Bibliometrix-package that was specifically designed for quantitative Bibliometrics research (Aria & Cuccurullo, 2017). The extraction of the keywords from the top cited papers was

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done by utilizing Microsoft Office Excel. The title of the top cited papers along with the abstracts and keywords were saved as excel sheet and the extraction process was done by checking each one individually.

Table 2. A comparison among three databases for search query.

Database	Title search results	Refined with topic search results
PubMed	3,914	40
Web of Science (WoS)	14,404	76
SCOPUS	16,163	182

Limitation

This study utilized 182 documents collected from SCOPUS databases. Therefore, it might be some documents on other well-known databases like PubMed and WoS, which were not included in this study.

Results

The number of documents, average citations per paper, authors per documents, and documents type in the research area of "COVID 19 and quality of education" are shown in Table 3. The 182 documents received 255 citations. The h-index was 8. The original h-index was formulated for measuring researchers' impact. H-index 8 means there were at least eight documents published in the "COVID 19 and quality of education" research area that each of them has been cited at least eight times. The average number of references per document was 41.72 (7,599/182). Therefore, the future researchers in "COVID 19 and quality of education" should consider the average of 42 references per document. There were 27 documents written by a single author. Additionally, the collaboration index that indicated the average number of authors in documents by multiple authors (Chaparro & Rojas-Galeano, 2021; Elango & Rajendran, 2012), was 4.34.

Table 3. Summary of collected bibliometric data about "COVID 19 and quality of education".

Description	Results
Timespan	2003:2021
Sources (Journals, Books, etc)	146
Documents	182
Total citations	255
Average citations per documents	1.401
References	7,599
DOCUMENT TYPES	
Article	128
Conference paper	34
Review	6
Editorial	5
Book chapter	3
Note	3
Data paper	1

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Letter	1
Short survey	1
DOCUMENT CONTENTS	
Keywords Index	1017
Author's Keywords	584
Authors	700
Authors of single-authored documents	27
Co-Authors per Documents	3.91
Collaboration Index	4.34

Publication trends

There were few documents (Aikenhead, 2011; Basman, 2003; Chen et al., 2009; Hoffman & Justicz, 2016) before 2019 when the COVID 19 pandemic rose globally. The most common keywords in the published documents before 2019, was Severe Acute Respiratory Syndrome (SARS). The first article written by Elumalai et al. (2019) investigated factors that affected the quality of e-learning during the covid-19 pandemic from the perspective of higher education students. The number of documents in the research area rose dramatically from one in 2019 to 47, and 130 in 2020, and 2021 respectively (the current year 2021 data was not complete). The publication trends show that the "COVID 19 and quality of education" research area will remain flourishing in the next few years. Aikenhead (2011) investigated 16 education indicators on the quality of science teaching. These indicators may show the extent to which quality of science teaching is being provided in a classroom, a school, or a school system. The author concluded that 9 of these indicators are reflecting the quality of science teaching and the other 6 indicators do not represent the quality of science teaching (Aikenhead, 2011). In 2003, a conference paper presented by Basman summarized the quality assurance of pharmacy education for three years of teaching experience. Later on, research on the assessing quality of a web-based learning system for nurses was conducted by Chen et al. in 2009. The findings demonstrate that all of the instrument's indicators are well-suited to measuring the quality of a web-based learning system and have good reliability and validity. Implications and limits are explored in light of the research findings (Chen et al., 2009). Hoffman & Justicz (2016) found that the automated techniques can assess news records more quickly, more cheaply, and perhaps more accurately than people.

Top keywords

In order to find emerging key phrases of the research area the data were analysed by VOSviewer version 1.6.17 software based on co-occurrence network of author's keywords (Figure 2). 56 keywords with at least five frequencies were selected out of 1,473 all keywords for the analysing process. The emerging key phrases represented with yellow colour were "service quality", "total quality management", "deep learning", and "algorithm". The smaller the distance between two nodes of Figure 2, the higher their relatedness (Van Eck & Waltman, 2014). The emerging keywords in Figure 2 which highlighted in yellow colour reflect a clear picture on the relationship between the quality measurement and the education with management. All these key phrases showed the importance of education quality and COVID 19. The other mentioned keywords which highlighted in different colours are also related and reflected the impact of covid19 on the teaching and learning quality worldwide.

Figure 3 illustrates the clustering view of "All Keywords" in the "COVID 19 and quality of education" research area. A cluster is a set of closely related nodes (here keywords). Each node in a network is assigned to exactly one cluster (Van Eck & Waltman, 2014). There were four clusters. Cluster one is indicated by red colour and consists of 23 keywords mainly "distance learning", "e-

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learning", "learning system", "quality of service", and "student satisfaction". Cluster two is indicated by green colour and consists of 18 keywords mainly "deep learning", "health care quality", "human experiment", "medical education", and "quality of life". Cluster three is indicated by blue colour and consists of 9 keywords mainly "pandemic" and "coronavirus disease". Cluster four is indicated by yellow colour and consists of 6 keywords mainly "algorithm" and "machine learning".

Furthermore, Cluster one (red colour) showed the keywords which are reflecting the connection between "COVID-19" and "education quality" keywords. For instance, there are 21 keywords in red colour, the keyword quality is repeated 7 out of 21 times (33%). Moreover, the word "education" or the related words to education, such as, "students", "learning", "teaching", "school" and "higher education" are repeated 13 times (61.9%), which means that the "quality" and "education" or "the words related to education keyword" were 20 words out of 21 (94.9%).

Over the above, cluster two (green colour) was more specific regards the keywords than cluster one. It links the "human" or "related words to human", such as "male", "female" and "adults" to the quality of education during the COVID-19 pandemic. 6 times the "human" and the "human related" keywords were repeated out of 18 times (33.3%). The other keywords of this cluster were "quality of life", "questionnaire", "health care quality" and "total quality management".

Additionally, cluster three, the blue colour keywords, has a total of 9 words, 7 of them were stating the "pandemic" and "pandemic related words", such as, "sars-cov-2", "coronavirus disease 2019". However, Cluster four (a yellow colour keywords) showed only six keywords. 50% of these keywords are related to "COVID-19" words or "COVID-19 related words" and all these words are linked to "machine learning" word.

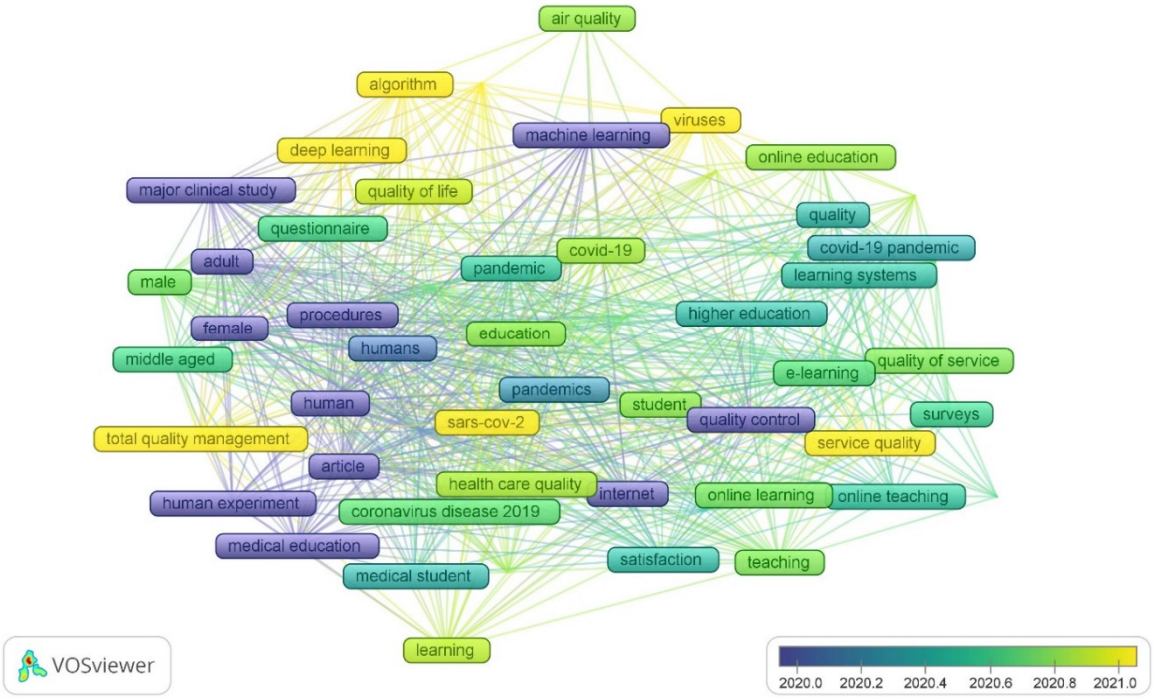

Figure 2. Overlay visualization of "All Keywords" co-occurrence network.

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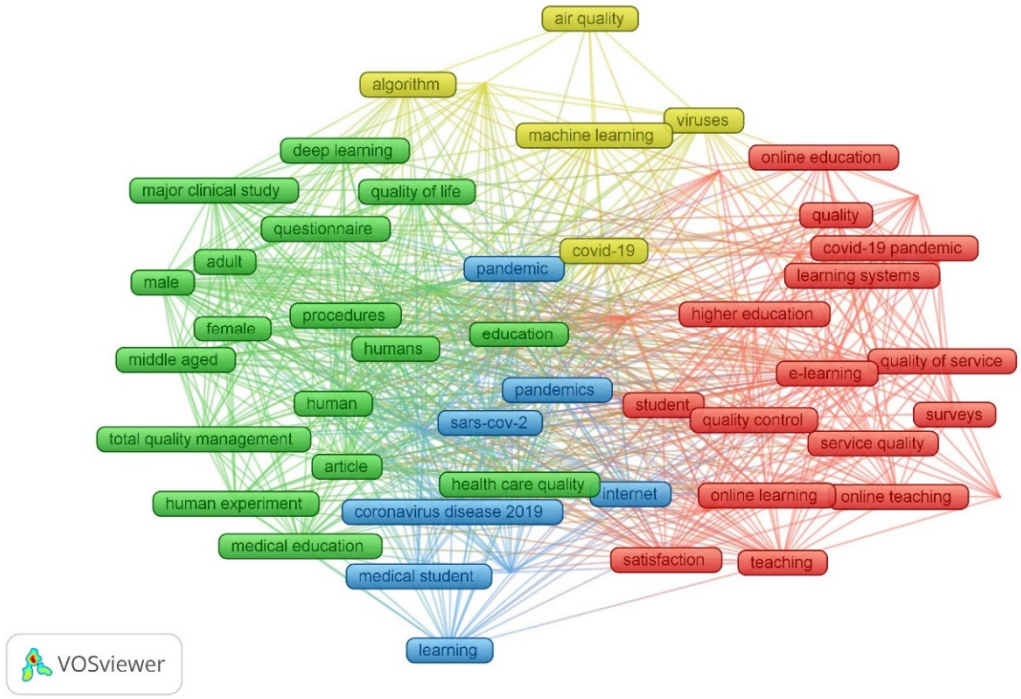
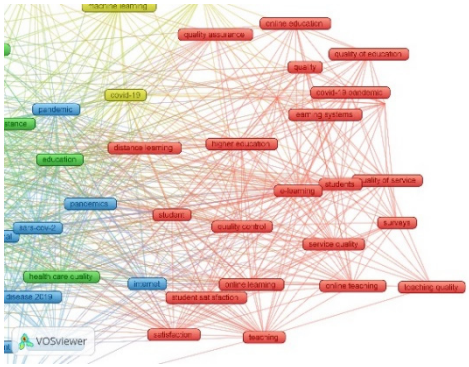
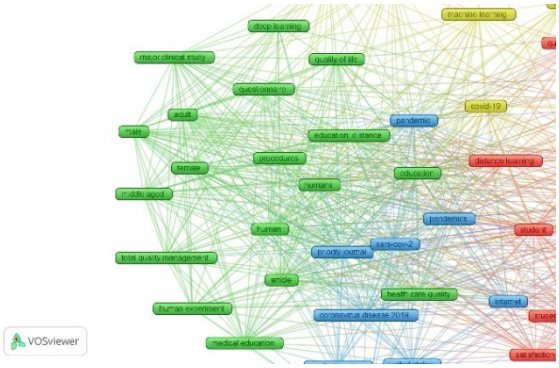
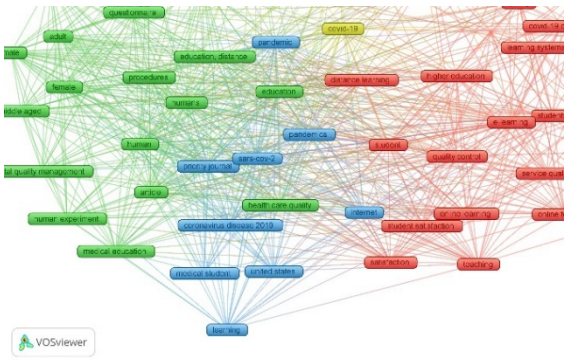




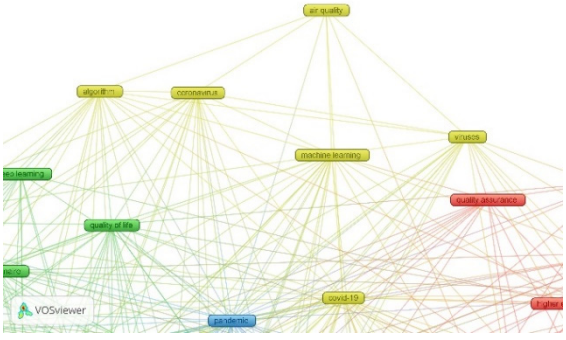
Cluster 1



Cluster 2



Cluster 3



Cluster 4

Figure 3. Clustering visualization of "All Keywords" co-occurrence network.

The most influential countries

The most influential countries in the "COVID 19 and quality of education" research area illustrated in Figure 4. There were three more countries, Indonesia, Russian Federation, and Saudi Arabia which were not shown in Figure 4 because they were not connected to each other. The United

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States with 29 publications, China (21), Indonesia and the United Kingdom (18) were top countries with the highest number of publications. A possible explanation for this might be that these countries are among the highest confirmed infected cases of COVID-19. For example, based on the world Health Organization (WHO) statistics; United Kingdom has 6,862,908 confirmed cases of COVID-19, while United States has 39,300,270 confirmed cases of COVID-19 and Indonesia reported 4,116,890 confirmed cases of the pandemic (WHO, 2021). The presence of China could be attributed to the origin of COVID-19 pandemic. Figure 5 illustrates countries' collaboration on the world map in the "COVID 19 and quality of education" research area.

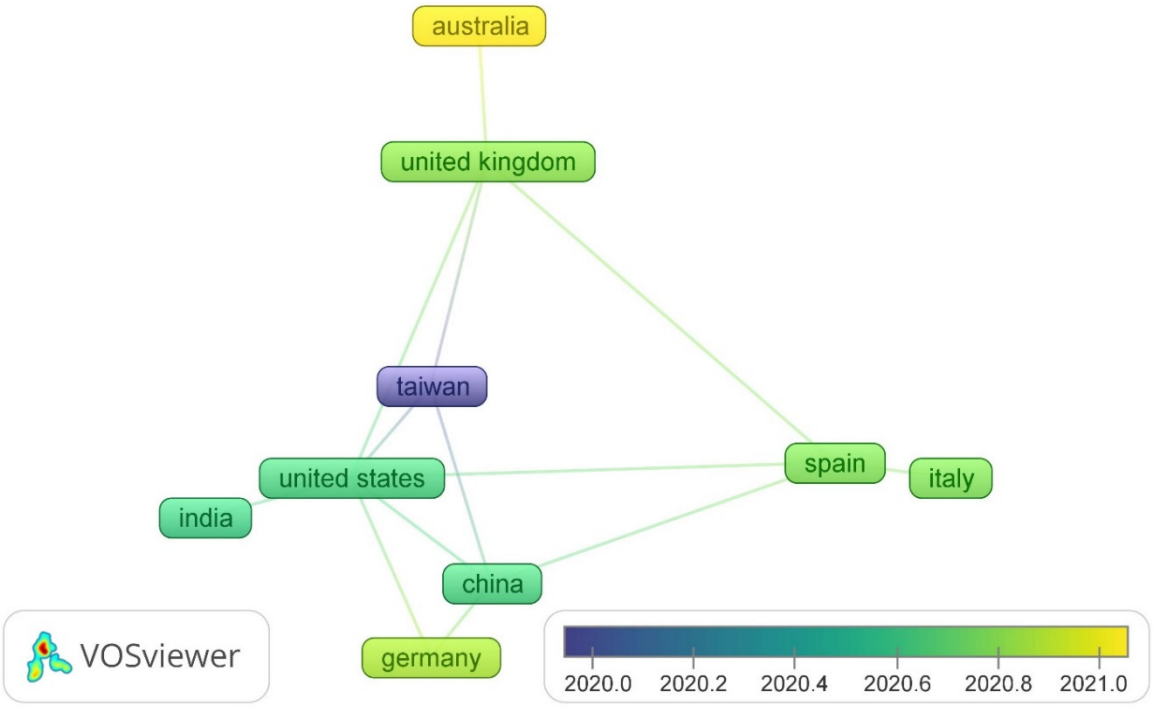

Figure 4. The most influential countries in the "COVID 19 and quality of education" research area.

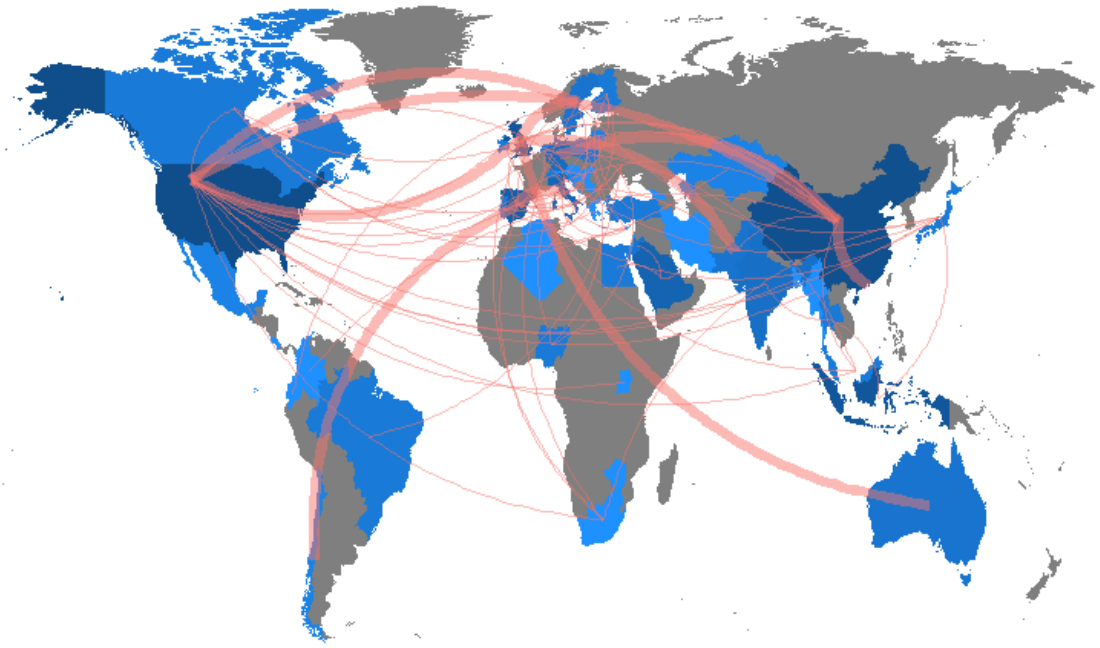

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Figure 5. Countries collaboration on the world map in the "COVID 19 and quality of education" research area.

The most influential sources

Source analysis helps to identify the distribution of core journals in the research area. The 182 documents in the research area of "COVID 19 and quality of education" published in 146 different sources (Journals, Books, etc). Table 4 and Table 5 shows Top 5 journals in the "COVID 19 and quality of education" research area sorted based on the number of publications and number of citations respectively. The h-index two for Sustainability (Switzerland) journal represented that the journal has at least two publications that each of them received a minimum of two citations. The relationship between sources, keywords, and countries were illustrated in Figure 6.

Table 4. Top 5 journals in the "COVID 19 and quality of education" research area sorted based on the number of publications.

No	Source	h_index	NP	NP-Rank	TC	TC-Rank	PY_start
1	SUSTAINABILITY (SWITZERLAND)	2	9	1	6	10	2020
2	ACM INTERNATIONAL CONFERENCE PROCEEDING SERIES	1	5	2	3	13	2020
3	JOURNAL OF PHYSICS: CONFERENCE SERIES	1	4	3	1	15	2020
4	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	1	3	4	5	11	2020
5	E3S WEB OF CONFERENCES	0	3	4	0	16	2020

(TC=Times Cited, and NP=Number of Publications).

Table 5. Top 5 journals in the "COVID 19 and quality of education" research area sorted based on the number of citations.

No	Source	h_index	NP	NP-Rank	TC	TC-Rank	PY_start
1	SYSTEMATIC REVIEWS IN PHARMACY	1	1	6	32	1	2020
2	EDUCATION SCIENCES	1	1	6	25	2	2020
3	JOURNAL OF MEDICAL SYSTEMS	1	1	6	24	3	2009
4	BMC MEDICAL EDUCATION	1	2	5	13	4	2020
5	THE PROFESSIONAL KNOWLEDGE BASE OF SCIENCE TEACHING	1	1	6	12	5	2011

(TC=Times Cited, and NP=Number of Publications)

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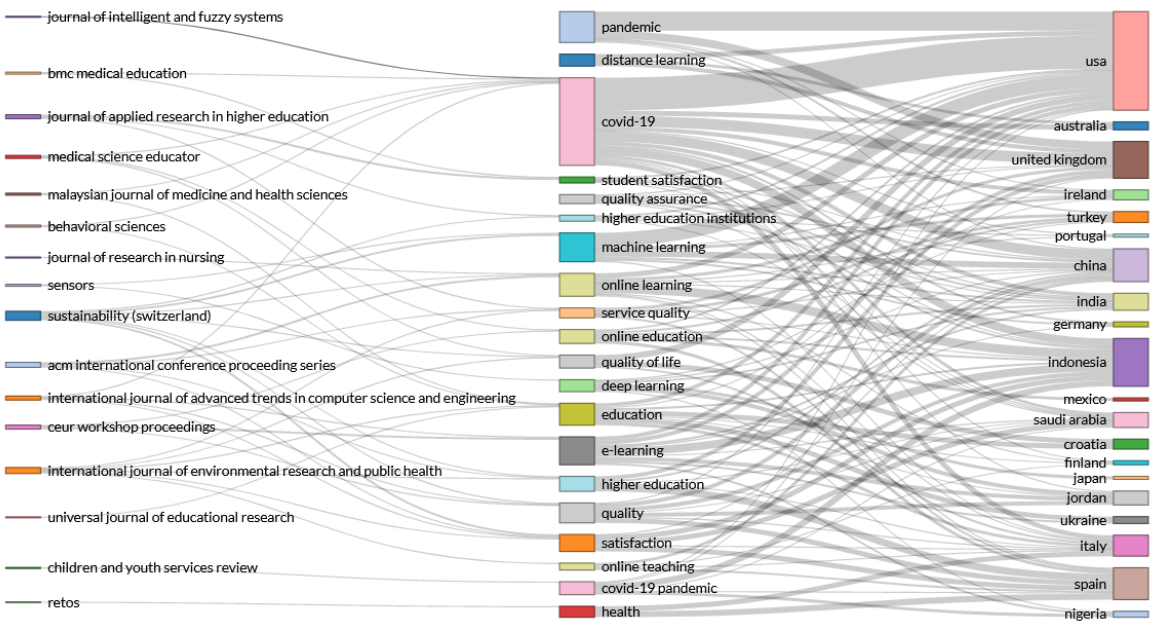

Figure 6. Three-Fields plot of sources, keywords, and countries (from left to right).

Main key phrases used by the most influential studies

Qualitative analysis of main key phrases used by the most influential studies, beside bibliometric study will elaborate more insight into scholarly outputs (Maghami et al., 2015). Therefore, in this study, the top 12 most frequently cited papers in the field of "COVID 19 and quality of education" analysed for discovering their main key phrases. The extracted data from SCOPUS database was arranged in an Excel sheet and the number of citations per year was calculated by dividing the total citation per year passed from the publication. The threshold for selecting top papers was 2.8 (two times of average citations per document (1.40) citations per year. There were 12 papers which met the selection criteria. The top 12 most frequently cited papers were reviewed and the common key phrases extracted (Table 6). Based on the keywords analysis, the repeated keyword in all top cited papers was "COVID-19". The "COVID-19" word was used in 8 articles, and another two articles used the words "Coronavirus" and "Corona". The rest of the articles have not used "COVID-19" or "Coronavirus" in their keywords section but they utilized it in the title of the paper and in the introduction part.

Table 6. Top 12 documents with highest times cited per year (TCpY).

Paper	Journal name	Total Citations	TCpY	Pandemic Covid-19	Distance learning	Quality	Higher education
(Suryaman et al., 2020)	Systematic Reviews in Pharmacy	32	16	1	1	-	-
(Lassoued et al., 2020)	Education Sciences	25	12.5	1	1	1	-
(Daumiller et al., 2021)	Computers in Human Behavior	11	11	1	-	-	-
(Fatani, 2020)	BMC Medical Education	13	6.5	1	1	1	-
(Silva et al., 2021)	European Journal of Dental Education	6	6	1	1	1	1

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(Dwidienawati et al., 2020)	International Journal of Advanced Trends in Computer Science and Engineering	9	4.5	1	1	1	-
(Kohan et al., 2020)	Pain Medicine (United States)	8	4	1	-	-	1
(Ramírez-Hurtado et al., 2021)	International Journal of Environmental Research and Public Health	4	4	-	1	1	1
(Omar, 2021)	International Journal of Advanced Computer Science and Applications	4	4	-	1	1	-
(Zheng et al., 2020)	Children and Youth Services Review	7	3.5	1	1	1	-
(Pulimeno et al., 2020)	Health Promotion Perspectives	6	3	1	1	1	1
(Bokayev et al., 2021)	Technology, Pedagogy and Education	3	3	1	1	-	-

Discussions

Discussion based on the bibliometric analysis

Quality has always been considered a vital component in the educational process. This study set out with the aim of assessing the effect of COVID-19 on the quality of education as a bibliometric review. This research is the first comprehensive global mapping and analysis of scientific studies on the impact of COVID-19 on educational quality. A large and growing body of literature has been published on COVID-19 and its relation to the quality of education since the start of pandemic. The date in Figure 1 for the selection of the keywords given a clear idea about the presence of correlation between the COVID-19 and the quality of education. However, the keywords research used in SCOPUS databases confirmed the correlation in the online survey. The repeated key phrases in all top cited articles, according to the keywords analysis, was "COVID-19." The remaining publications did not have “COVID-19” or “Coronavirus” in their keywords section but did include it in the title of the study and the introduction part. A possible explanation for this might be that the keyword “COVID-19” is the main significant word which may change the quality of teaching and learning. Moreover, this is the main reason by which these articles gained more citations. There are, however, other possible explanations; the researchers noticed the changes in the quality of education by using online-based learning instead of face to face is reflecting the COVID-19 impact. Furthermore, we noticed that “learning”, “online learning”, “quality” and “education” keywords were repeated more than one time. These results are likely to be related to the quality of education through online learning and COVID-19. The data from Figure 3 showed the high percentage (94.9%) of the keywords mentioned in the cluster one, it my gives clear evidence of the impact of COVID-19 on the quality of education. Further analysis, cluster two keywords are comparable to those keywords used in cluster one. While cluster three and cluster four both described the COVID-19 and relates it to the online based learning. In view of all that has been mentioned so far, it is interesting to note that in all four clusters of this study was showed a strong relationship and similarities between COVID-19 and quality of education. Moreover, other keywords such as “online based learning”, “video conferences” or “other related words to online learning” were seen the keywords analysis. This may explain the transformation of the way of delivering the knowledge from face to face to online based learning given another indicator of COVID-19 to the quality of education. The top countries with the highest number publications about COVID-19 and quality education seen in Figure 4. The single most striking observation to emerge from the data comparison was that Indonesia appeared as one of those top countries. This result may be explained by the fact that Indonesia is one of the top countries with confirmed COVID-19 cases. Moreover, the publishing patterns indicate that the study area of "COVID

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19 and quality of education" will continue to thrive in the next few years. No repeated journal name was seen in Table 4 and Table 5 for the top five journals about the COVID-19 and education quality based on the number of publications and the number of citations respectively. This may indicate the diversity theory of the publications related to the topic in different journals. This theory was supported by the data shown in Table 6 where no journal name was repeated in the top 12 cited papers in COVID-19 and quality of education topic.

Discussion based on the narrative review for quality of education and COVID-19

Significant results emerged in the bibliometric study looking into how COVID-19 affected the standard of education, especially in terms of PEO, PLO, and CLO (Program Educational Outcome, Program Learning Outcome, and Course Learning Outcome). The findings revealed that the quality of education declined as a result of the shift from traditional classroom instruction to online learning (Fatani, 2020; Lassoued et al., 2020; Ramírez-Hurtado et al., 2021). This change in distribution style offered both new obstacles and new opportunities to students, educators, and educational institutions. Using data from 182 documents retrieved from the selected databases on August 24, 2021, researchers were able to demonstrate the significant impact that PEO, PLO, and CLO had on the standard of education. PEOs are the overarching goals of a program, whereas PLOs are the more narrowly defined set of skills and knowledge that students are supposed to acquire at the end of the entire program or study level. Conversely, course-level objectives (CLOs) describe the information, abilities, and dispositions that learners should have after completing a certain course or subject. Researchers discovered that the COVID-19 pandemic prompted a rapid transition to online education, which had varying effects on the accomplishment of PEOs, PLOs, and CLOs. Teachers and students alike have had to quickly learn and use new tools and platforms as part of the shift to online education. For people who were not accustomed to using computers and online courses, this meant a steep learning curve. As a result, PEO, PLO, and CLO achievement took a decline as students struggled to adjust to this novel approach to learning. Furthermore, the study found that the success of online learning in attaining PEOs, PLOs, and CLOs varied depending on the students' level of access to digital resources and their reliability of internet connectivity. A digital divide emerged as a result of these inequalities, making it harder for students from low-income families or living in remote regions to participate in online learning opportunities. Students who fell into this digital divide had a harder time getting the knowledge they needed to succeed in the modern world (Fatani, 2020; Lassoued et al., 2020; Ramírez-Hurtado et al., 2021). PLOs, which define the specific competencies students should acquire by the end of a program, have also been affected, with educators emphasizing fostering knowledge retention, practical skills, and comprehension levels in a virtual environment. As the reliance on technology has increased, the importance of numerical and digital skills has risen, and educators have integrated innovative tools to facilitate learning and assessment. As part of the CLOs, which outline the desired outcomes for each course, educators have restructured course content and delivery methods to accommodate diverse learning styles and guarantee the development of critical skills. As the pandemic has highlighted the need for resilience and adaptability in the workforce, professionalism, management skills, and entrepreneurial skills have also been emphasized as crucial components of the learning process(Pokhrel & Chhetri, 2021).

During the COVID-19 pandemic, the level of proficiency in PEO, PLO, and CLO is contingent on factors such as institutional readiness, access to technology, and student engagement. Adapting to remote learning has presented unique difficulties, and the extent to which PEOs, PLOs, and CLOs have been attained varies between programs and institutions. In relation to PEOs, PLOs, and CLOs, the transition to online learning has been relatively seamless for some institutions, allowing them to maintain or even enhance the quality of education. Utilizing digital platforms, virtual simulations, and online resources has enabled students to acquire knowledge, develop practical skills, and achieve a deeper comprehension of course content. In addition, the increased emphasis on numerical, digital, and entrepreneurial skills has assisted in preparing students for the technological demands of the future. However, not all institutions have achieved the desired results with equal success. Inadequate infrastructure, lack of access to technology, and disparities in digital literacy have impeded the development of some programs, resulting in lower achievement levels for PEOs, PLOs, and CLOs. In

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addition, the absence of face-to-face interactions and the difficulties of distance learning may have hindered students' ability to develop essential skills such as professionalism, management, and teamwork (Omar et al., 2021; Pokhrel & Chhetri, 2021).

The COVID-19 pandemic has presented additional obstacles to attaining PEOs, PLOs, and CLOs in applied science programs, where hands-on practical skills are integral to learning. The transition to remote learning has significantly impacted students' capacity to engage in traditional laboratory-based experiences, making it more challenging for them to develop the practical skills necessary for their disciplines. To address this issue, some institutions have instituted innovative solutions to simulate hands-on experiences for applied science courses. Virtual laboratories and simulations, for instance, have been utilized to provide students with an interactive learning environment that closely resembles the in-person laboratory experience. These digital tools enable students to conduct experiments, manipulate equipment, and analyze data, nurturing the growth of practical skills and reinforcing theoretical knowledge. In addition, institutions have sought to combine remote learning with limited in-person sessions for essential hands-on components of applied science courses while adhering to stringent safety protocols. This hybrid approach permits students to practice their practical skills in a supervised setting while maintaining social distance and taking other precautions. Despite these efforts, it may be impossible to thoroughly replicate the hands-on experience typically provided in applied science courses. Some students may not have access to the technology or resources necessary to participate in virtual simulations, and diminished face-to-face interaction may hinder the development of collaboration and communication skills (Jayakumar et al., 2022; Joia & Lorenzo, 2021; Müller et al., 2021).

While the transition to online education has not been without its difficulties, bibliometric studies have uncovered various potential and beneficial consequences. Teachers are now able to create more dynamic and adaptable lessons for their students through the use of cutting-edge technological tools and new approaches to education. Furthermore, online learning systems allowed for more accurate tracking of student progress, which in turn allowed for more immediate feedback and more specifically focused interventions to boost PEO, PLO, and CLO attainment (Aikenhead, 2011; Basman, 2003; Chen et al., 2009; Hoffman & Justicz, 2016). The current study also stressed the value of cooperation between universities, governments, and technological companies in meeting the difficulties faced by the pandemic. More efficient tactics and resources to back up online learning and improve education have been developed largely to the formation of partnerships and the sharing of best practices (Omar, 2021).

Conclusions

The aim of the present research was to examine the relation and impact of COIV-19 on the quality of education in a bibliometric way. This part concluded the possible phenomena that might explain the patterns found in the analysis and comparisons, based on the data provided in the preceding section. The most obvious finding to emerge from this study is that COVID-19 has clear impact and strong relation on the quality of education. This was based on the data provided statistically in the current study. The impact and relation grew in a very short time from end of 2019 to the end of 2021 and this showed how important is the quality of education comparison between face to face and online based learning. Taken together, these findings added a confirmation criterion of the quality of education that may get impacted by the changing of the education delivery from face to face to the online based learning. One source of weakness in this study which could have affected the measurements of the COVID-19 and education quality was the analysis of papers published in SCOPUS databases. Therefore, more information on this topic in other databases such as, WoS and PubMed would help us to establish a greater degree of accuracy on this matter. This bibliometric analysis focused also on the relationship between COVID-19 and the accomplishment of PEOs, PLOs, and CLOs in order to illustrate the complexity of this issue. Challenges and possibilities for making the transition to online education during the epidemic were highly context- and resource-specific. Stakeholders in education must keep looking for new ways to overcome these obstacles and provide children with the best education possible, regardless of where or how they receive their instruction.

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