


RESEARCH ARTICLE | SEPTEMBER 09 2024


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AIP Conf. Proc. 3065, 030034 (2024)

<https://doi.org/10.1063/5.0224649>







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
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A Bibliometric Analysis of the Impact of COVID-19 on Distance Learning: Trends, Challenges, and Opportunities

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Abstract. This bibliometric analysis aims to explore the impact of COVID-19 on distance learning through a comprehensive review of the scholarly literature. Using the Scopus database, a total of 754 articles were retrieved over the period 2020-2023 and analyzed using bibliometric techniques such as citation analysis, co-authorship analysis and keyword analysis. The study shows key trends, challenges and opportunities in distance learning as a result of the pandemic. The results suggest that the COVID-19 outbreak has accelerated the adoption and innovation of distance learning technologies, but has also brought to light challenges such as the digital divide and pedagogical concerns. The study also highlights the need for further research into the effectiveness of distance learning, particularly in addressing equity issues and promoting student engagement. The analysis also revealed opportunities for the education sector, such as improved access to education, more flexible learning options and the development of new technologies to support distance education.

Keywords: Bibliometric, Covid-19, Distance Learning, Distance Education

INTRODUCTION

The COVID-19 pandemic has caused unprecedented disruptions to the world's education systems, forcing institutions to rapidly transition to online and distance learning. This shift has led to significant changes in the ways that education is delivered, accessed, and assessed[1]. As such, there is a growing need to understand the impact of COVID-19 on distance learning and to identify trends, challenges, and opportunities for future research and practice[2]. Bibliometric analysis has emerged as a valuable tool for comprehensively analyzing and characterizing scientific literature within a specific discipline[3]. This methodology is founded on the quantitative analysis of bibliographic data from scholarly publications, such as citations, author affiliations, and keywords, to identify critical areas of focus and trends in the field. Through bibliometric analysis, scholars can assess the impact of research, evaluate research productivity, and investigate the dissemination and reception of knowledge[4].

In this paper, we present a bibliometric analysis of the impact of COVID-19 on distance learning, focusing on trends, challenges, and opportunities for future research and practice. Specifically, we use the Scopus database to retrieve a representative set of scientific publication information on COVID-19's impact on distance learning, using

a search string that includes "distance learning" and "COVID-19" keywords in article titles, abstracts, and keywords[5]. Once the data cleaning process was completed, we obtained a comprehensive collection of 754 documents for our bibliometric analysis. We utilized the R-Language software's Bibliometrix package to analyze the bibliographic data of these documents[6]. This package is a powerful tool that offers an array of options for processing, analyzing, and visualizing data, which ultimately increases the accuracy of publication data processing. The Bibliometrix package has several features such as file conversion, term extraction, duplicate matching, and merging, which helps researchers to conduct a meticulous analysis of the publication data. Moreover, this package allows for the in-depth exploration of data through comprehensive descriptive analysis, matrix building, and network analysis.

Our analysis reveals several key findings, including the top-cited articles, the most productive authors and institutions, and the main research themes and topics. We also identify challenges and opportunities for future research and practice, including the need for more research on the impact of COVID-19 on specific student populations, the role of technology in facilitating distance learning, and the importance of considering equity and access issues in distance education. Overall, this study provides a comprehensive analysis of the impact of COVID-19 on distance learning, highlighting key trends, challenges, and opportunities for future research and practice. The results of this study can inform the development of policies and practices that support effective distance learning in the post-pandemic era.

METHODS

Bibliometric analysis has become a valuable method for comprehensively analyzing scientific literature in a specific field. This methodology uses quantitative analysis of bibliographic data, including citations, author affiliations, and keywords, to identify key areas of focus and trends in the field. Through bibliometric analysis, researchers can assess the impact of research, evaluate research productivity, and investigate the dissemination and reception of knowledge. This method has been widely adopted in numerous disciplines, including natural sciences, social sciences, and humanities, and has been instrumental in mapping the intellectual landscape of various research fields. By using bibliometric techniques, researchers can gain a deeper understanding of the research landscape, identify knowledge gaps, and explore new avenues for future research[7], [8][9]. Bibliometric analysis is a valuable method for examining scientific literature across various disciplines.

By analyzing bibliographic data, such as citations, author affiliations, and keywords, researchers can identify critical areas of focus and trends in a specific field. This method is useful in assessing the impact of research, evaluating research productivity, and investigating the dissemination and reception of knowledge. The use of bibliometric techniques is widespread and has enabled scholars to map the intellectual landscape of different research fields[10][11]. Through this method, scholars can gain a better understanding of the research landscape, identify gaps in knowledge, and explore new areas for future research. Indicators are utilized in our study at the author, document, and country analysis levels to provide a multifaceted view of the research on the impact of Covid-19 on distance education. This approach allows for a thorough analysis of publication information and facilitates the generation of comprehensive insights and recommendations for academia and policy-making[12].

In this research, we employed a keyword analysis technique in addition to metrics to assess publication performance at different levels. The use of literature keywords extracted from author keywords allowed us to develop a semantic field map that helps in comprehending the structure and focus of published works[13]. Our analysis also involved exploring keyword associations through shared word analysis, a type of content analysis that creates a scientific map of a field. By identifying relationships between the primary keywords of existing research streams, we created a thematic map that enabled us to discern research topics, significant expressions, and relationships. This systematic method aided in uncovering subfield relationships and tracking phenomena in the literature[14].

For this study, we utilized the Scopus database as the primary source of data, which houses a vast collection of academic documents, including scientific journals and books, across multiple disciplines[5]. To ensure a comprehensive set of publications related to the impact of Covid-19 on distance education, we conducted a search using the following search string; article title: "distance education" and article Title, Abstract, Keywords: "covid-19." Our search period extended until April 2023, which is the latest available period during the analysis. To ensure the quality of our data, we limited our search to only include journal articles and proceedings papers.

We retrieved a total of 754 documents for analysis after the data cleaning process. Bibliographic data of the retrieved documents were analyzed using the "bibliometrix" package in R Language software, which offers a wide range of options for data processing, analysis, and visualization[6]. The package includes features such as file

conversion, term extraction, duplicate matching, and merging. Additionally, it provides researchers with tools for descriptive analysis, matrix building, and network analysis to present results accurately.

RESULTS AND DISCUSSION

Table 1 presents a concise summary of the fundamental characteristics of the samples acquired from the selected databases that were utilized for subsequent analysis. Notably, the earliest publication related to the Impact of COVID-19 on Distance Learning, as identified by the Scopus database, dates back to 2020, indicating that our analysis spans over a period of three years that were dominated by the unprecedented effects of the pandemic on education. The table further illustrates that the majority of the analyzed documents were journal articles, accounting for 77.1% of the total publications, followed by a significant number of review publications, with a cumulative count of 754. These findings highlight the extensive literature on the subject matter, emphasizing the need for a comprehensive and meticulous analysis to synthesize the relevant information and extract meaningful insights.

TABLE 1. Main Information About Data

Description	Results
Timespan	2020:2023
Documents	754
Article	581
Conference Paper	173
Annual Growth Rate %	-20.86
Average citations per doc	6.72
Authors	2729
Authors of single-authored docs	96
Co-Authors per Doc	3.8
International Co-Authorships %	14.32

The analysis of scientific publications revealed that the contribution to the literature on the subject matter was from a total of 2729 authors, with the majority of the publications comprising journal articles (n=581) and proceedings papers (n=173). Notably, the prevalence of collaborative research was apparent, as only a meager 96 of the total publications were single-authored papers. This finding indicates that the subject matter under scrutiny requires multidisciplinary expertise and collective efforts to unravel the complexities and nuances inherent in the research question. The prevalence of collaborative research highlights the importance of partnerships and interdisciplinary collaborations in advancing scientific research and enhancing the quality of publications. Furthermore, the predominance of journal articles in the literature underscores the significance of peer-reviewed journals as a primary source of scientific information, providing a rigorous and systematic mechanism for evaluating the quality and reliability of research outputs.

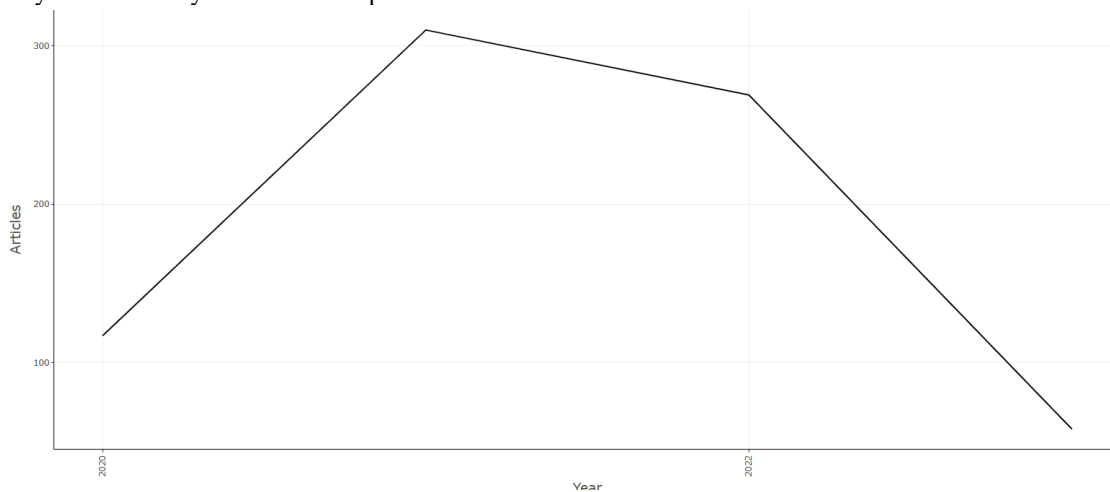


FIGURE 1. Annual Scientific Production

Publication Source Analysis

Table 2 enumerates the most influential publication sources concerning the quantity of scientific documents published in those outlets, as well as the corresponding citation counts accrued by these publications. Notably, our analysis reveals that the Journal of Physics Conference Series occupied the topmost position in terms of the volume of papers published on the subject matter of the impact of COVID-19 on distance education, followed by Education Sciences and AIP Conference Proceedings. These findings suggest that the aforementioned publication sources have played a vital role in disseminating scientific knowledge and stimulating research activity in the field of distance education in the wake of the COVID-19 pandemic.

The predominance of the Journal of Physics Conference Series in this context may be attributed to its established reputation as a prestigious forum for the publication of high-quality research outputs in the field of physics and related disciplines. Similarly, the popularity of Education Sciences and AIP Conference Proceedings as a favored outlet for the dissemination of research findings in the field of education and related domains underscores their significance in shaping the discourse on distance education in the current era.

TABLE 2. Most Publishing and Influential Sources

No.	Source	NP	PY Start	TC	h index
1	Journal Of Physics: Conference Series	19	2020	38	4
2	Education Sciences	16	2020	303	7
3	Sustainability (Switzerland)	14	2021	187	6
4	AIP Conference Proceedings	14	2021	3	1
5	E3S Web of Conferences	12	2020	38	4
6	Asian Journal of University Education	11	2020	67	4
7	ACM International Conference Proceeding Series	11	2020	15	2
8	CEUR Workshop Proceedings	11	2020	9	1
9	International Journal Of Environmental Research And Public Health	9	2020	164	3
10	Turkish Online Journal Of Distance Education	9	2021	30	3

When considering the total citations (TC) and the h-index, the ranking of publication sources differs significantly from that based on the number of publications. Specifically, BMC Medical Education emerged as the publication outlet with the highest citation count (TC = 535), followed by Education Sciences (TC = 303) and Journal of Chemical Education (TC = 267). These findings suggest that the publications in these journals have had a profound impact on the academic discourse on the impact of COVID-19 on distance learning, reflected in the extensive citation counts accrued by their articles. In contrast, the most frequently published journal, Journal of Physics: Conference Series, drops to the eighth position if we use the h-index as a measure of impact. This indicates that while the journal published a considerable volume of papers on the subject matter, the citations received by these publications were not as extensive or impactful as those in other journals with a lower publication output.

Notably, the highest h-index scores were recorded for Education Sciences and Journal of Chemical Education, underscoring the influential role played by these journals in shaping the discourse on distance education during the pandemic era. These findings highlight the importance of considering multiple bibliometric indicators in evaluating the impact and significance of academic publications, as each measure offers unique insights into the scholarly contribution of individual publications and outlets.

Country Analysis

The distribution of scientific publications across different countries and institutions can provide valuable insights into the geographical concentration of research on a particular topic. Accordingly, we present a detailed account of country-specific publication data in Table 3 to shed light on the regional variations in scholarly output related to the impact of COVID-19 on distance education. Additionally, Table 3 also offers valuable insights into the collaborative nature of leading countries' scientific output, as evident from the prevalence of single-country publications (SCP), multiple-country publications (MCP), and multiple-country publication ratio (MCPR). By examining these indicators, we can gain a comprehensive understanding of the degree of international collaboration and cooperation in research endeavors related to distance education in the context of the ongoing pandemic. Such insights are crucial for identifying opportunities for cross-border collaborations and partnerships to facilitate the dissemination of scientific knowledge and the development of innovative solutions to the challenges posed by the pandemic.

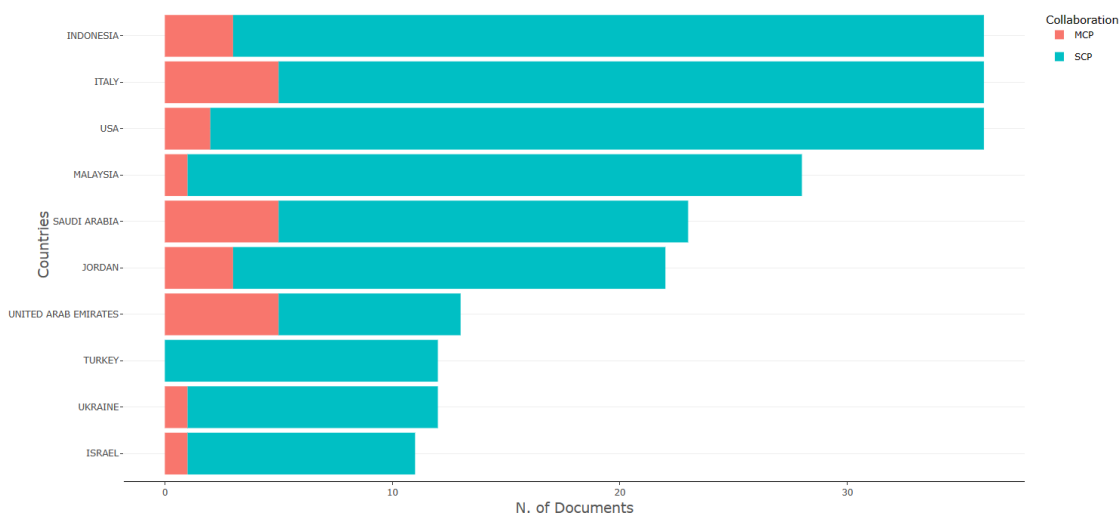


FIGURE 2. Corresponding Author's Countries (Collaboration MCP and SCP)

Remarkably, Indonesia emerged as the leading contributor to international collaborations in publishing related articles, as revealed by the prevalence of joint-authorship publications involving scholars from different countries. Specifically, out of the 36 publications from Indonesia that were analyzed, 33 were single-country publications (SCP), while the remaining 3 were published in collaboration with authors from multiple countries (MCP). These findings underscore the crucial role played by Indonesian scholars in fostering cross-border research collaborations and partnerships aimed at advancing the understanding of the impact of COVID-19 on distance education. The significant contribution of Indonesia to the global scientific discourse on the subject matter also highlights the importance of fostering international collaborations to tackle the complex challenges posed by the pandemic, including the rapid transformation of the education sector.

The emergence of Indonesia as a leading contributor to international collaborations in publishing related articles underscores the dynamic and evolving nature of cross-border research collaborations. The factors that contribute to this trend are likely multifaceted and may include a range of social, cultural, and economic factors. One possible explanation for Indonesia's high levels of collaboration is the country's history of cultural exchange and openness to international cooperation. Indonesia is a diverse and multicultural country that has a long tradition of engaging with other cultures and societies. As such, academics in Indonesia may be more inclined to collaborate with researchers from other countries and share their expertise and knowledge.

Document Analysis

In this section, we present a comprehensive analysis of the top publications that have contributed significantly to the discourse on the impact of Covid-19 on distance education. The extensive coverage of this topic in scholarly publications reflects its crucial significance and relevance among researchers in the current scenario. To rank the most impactful publications, we adopted a rigorous approach that considered the total citations received by each document. This parameter is widely used as a standard metric to evaluate the significance and influence of scholarly publications in their respective fields. Our document analysis revealed a diverse range of studies that explored various facets of the impact of Covid-19 on distance education. The top ten publications in terms of their total citations are presented in Table 3, along with relevant information about the authors, publication outlets, and other pertinent details. The findings from our analysis highlight the significance of these publications in shaping the discourse on distance education in the context of the pandemic. These studies offer valuable insights and perspectives that can inform policy decisions, guide educational practices, and advance the field of distance education in the post-pandemic era.

The corpus of literature on the impact of Covid-19 on distance education comprises several publications, ranging from studies that focus on specific aspects to those that provide a comprehensive analysis of the subject matter. Among these publications, the article by Aryayev et al. (2020) stands out as the oldest one, with a publication date of 2020[15]. The study, titled "First experience of distance learning at medical universities in Ukraine under COVID-19 quarantine conditions," examines the initial experiences of implementing distance learning in the pediatrics discipline for 5th and 6th year students at the National Medical University of Odessa, as well as in the

continuous professional development of medical doctors. The study was conducted during the COVID-19 pandemic, when the whole of Ukraine was under quarantine. The paper was published in Child's Health Volume 15 in 2020 and is written in Russian. The study's findings provide valuable insights into the challenges faced by educators and learners during the initial stages of implementing distance learning in medical education, under the unprecedented circumstances brought about by the pandemic.

The dataset under analysis encompasses a wide range of articles on the impact of COVID-19 on distance learning. The most recent article in the dataset is published in BMC Medical Education, Volume 23, 2023, which investigates students' perceptions of distance learning during the COVID-19 pandemic in Saudi Arabia[16]. Alzahrani et al. (2023) conducted this study to evaluate and compare students' perceptions of synchronous and asynchronous teaching modes using their teaching-learning during the mandatory online teaching mode at the height of the COVID-19 pandemic.

According to the authors, both synchronous and asynchronous online learning were positively perceived by the students. The study suggests that depending on the topic content and the desired learning outcomes, a mix of synchronous and asynchronous methods can be chosen, since both methods have advantages and disadvantages. This study provides valuable insights into student perspectives on the effectiveness of online learning in the context of the COVID-19 pandemic, which can inform the design and implementation of online learning programs in the future.

TABLE 3. Top Cited Publications

No.	Document Title	Author	TC	Finding
1	"Distance learning in clinical medical education amid COVID-19 pandemic in Jordan: current situation, challenges, and perspectives"	Al-Balas et al. (2020)[17]	254	According to the study's findings, distance learning can serve as a feasible approach to sustaining learning during unprecedented and urgent circumstances like the outbreak of COVID-19.
2	"Student perspective of classroom and distance learning during COVID-19 pandemic in the undergraduate dental study program Universitas Indonesia"	Amir et al. (2020)[18]	192	The findings of the study revealed that distance learning (DL) can be an effective mode of learning, providing learners with more flexibility and time to review and study materials. However, communication between learners and educators was found to be a challenging aspect, leading to lower levels of satisfaction among learners.
3	"Students' acceptance of the covid-19 impact on shifting higher education to distance learning in Poland"	Rizun et al. (2020)[19]	149	The study found that Enjoyment is the best predictor of students' acceptance of distance learning, followed by Self-Efficacy.
4	"An exploratory study of the obstacles for achieving quality in distance learning during the covid-19 pandemic"	Lassoued et al. (2020)[20]	143	The study found that professors and students faced self-imposed, pedagogical, technical, and financial or organizational obstacles to distance learning. The study provides recommendations for overcoming these obstacles in the future.
5	"Attempts, successes, and failures of distance learning in the time of covid-19"	Dietrich et al. (2020)[21]	130	The study found guidelines to help us learn the lessons of this experience (Covid-19 pandemic) and face the future with more knowledge and successful distance learning.
6	"Distance learning in the era of COVID-19"	Schneider et al. (2021)[22]	113	According to the study, distance or online learning has become the standard approach amidst the challenges posed by the ongoing pandemic. To ensure the continuity of medical education during these difficult times, numerous national and international academic societies have pooled their resources.
7	"Barriers to distance learning during the COVID-19 outbreak: A qualitative review from parents' perspective"	Sawsan Abuhammad (2020)[23]	97	The study found the parents were have faced various types of barriers while assisting their children with distance learning during the pandemic.
8	"Covid-19 and higher education: First-year students' expectations toward distance learning"	Cicha et al. (2021)[24]	96	Based on the research, the most significant factors influencing students' feelings about distance learning and their willingness to transition from traditional classroom-based education are the sense of enjoyment and self-efficacy. These two factors have a crucial impact on students' overall attitude towards distance learning, making them more open to embracing this mode of education.
9	"Educational gains of in-person vs. distance learning in primary and secondary schools: A natural experiment during the COVID-19 pandemic school closures in Switzerland"	Tomasik et al. (2021)[25]	94	The study finds that secondary school pupils are largely unaffected by the school closures, while primary school pupils experience a slowdown in learning and an increase in interindividual variance in learning gains.
10	"COVID-19 and Distance Learning: Effects on Georgia State University School of Public Health Students"	Armstrong-Mensah et al. (2020)[26]	94	The main finding of the study is that despite the challenges caused by the abrupt shift to distance learning, students at Georgia State University School of Public Health (GSU SPH) were still motivated to learn and complete their assessments and assignments on time.

Al-Balas et al. (2020) conducted a study on the impact of COVID-19 on distance learning in clinical medical education in Jordan. Their research focused on medical students in clinical years across all Jordanian medical universities. The study found that while distance learning is a rapidly growing approach for medical students at all levels, it presents a significant challenge in acquiring clinical medical skills. Students prefer a blended approach to teaching, with a combination of in-person and online learning. The researchers also found that satisfaction with distance learning is influenced by the student's previous experience with distance learning and the instructor's experience and teaching style. This article has become the most influential article among the top ten cited articles related to the impact of COVID-19 on distance education, with 254 citations on Scopus. The findings of this study provide valuable insights into the challenges of distance learning in clinical medical education and suggest that a blended approach to teaching may be more effective for medical students in acquiring the necessary clinical skills.

The five most cited articles on distance learning and education during the COVID-19 pandemic highlight the challenges and opportunities presented by the sudden shift to remote learning. While students generally found distance learning to be an effective alternative to classroom learning, challenges related to technical and infrastructure resources were identified as significant barriers to implementation. Instructor experience and interaction were also found to be crucial factors in student satisfaction with distance learning.

The articles also emphasized the importance of incorporating blended learning in the curriculum to improve the overall learning environment. Additionally, the need for policy-making to support distance learning in case of future disruptions and comparative research to get a wider picture of the impact of the pandemic on higher education was also highlighted. The experiences of teachers and students during the pandemic have led to the development of guidelines and strategies to improve distance learning and have demonstrated the importance of human creativity and flexibility in developing effective pedagogies.

Research Keywords and Trend Topics

Following our analysis of the authors, sources, documents, and countries, we proceed to report the outcomes of our keyword analysis utilizing bibliometric techniques. By analyzing the frequency and co-occurrence of keywords, we are able to uncover the most prominent themes and topics within the literature. These results are presented in Table 4 and shed light on the key areas of focus within the field of distance learning, as well as the relationships between these topics. Furthermore, we employ shared word associations to create a thematic map that provides a visual representation of the conceptual structure of the research. By identifying commonalities between keywords and grouping them into clusters, we are able to better understand the overarching themes and sub-themes that emerge from the literature.

This approach allows us to gain a deeper insight into the relationships between different concepts and how they contribute to the overall discourse on distance learning. Together, our keyword analysis and thematic mapping provide a comprehensive overview of the key topics and trends within the field of distance learning, and offer valuable insights for researchers and practitioners alike.

TABLE 4. Most Frequent Words (Author's Keywords)

Words	Occurrences
distance learning	383
covid-19	279
online learning	61
covid-19 pandemic	58
higher education	57
pandemic	51
e-learning	46
education	37
distance education	35
students	27

Table 4 presents a comprehensive breakdown of the ten most frequently used publications in the study, along with the relative occurrence of author's keywords. Notably, the term "distance learning" was the most commonly used keyword, appearing a total of 383 times and accounting for 28% of all keywords used in this research. This result is hardly surprising given the significant shift towards remote learning due to the Covid-19 pandemic. Furthermore, the study found that Covid-19 accounted for approximately 20% of the total keywords used, indicating the unprecedented impact of the pandemic on the field of distance education. Other keywords that appeared

frequently in the publications included "online learning," "covid-19 pandemic," "higher education," and "pandemic," with these terms accounting for about 4% of the total keywords used in this study.

These results suggest that Covid-19 has brought about a paradigm shift in the way we approach distance learning, with researchers and educators exploring new approaches and strategies to navigate the challenges posed by the pandemic. It is surprising that the term "distance education" is not widely used by researchers as it accounts for 3% of the author's keywords used in this dataset. Interestingly, the researchers used the term "distance learning" more than "distance education" by a margin of 28% and 3%. This may be because the term "distance learning" is more frequently used in popular discourse and media coverage than "distance education", which may have influenced the researchers' choice of language. The term "distance learning" can be seen as more inclusive, as it covers a wider range of educational experiences and technologies, such as online learning and e-learning, while "distance education" can be seen as more limited in scope.



FIGURE 3. Trend Topics Based on Author's Keywords

However, analysis of topic trends (Fig. 2) shows that in 2022 the term "distance education" will be used more frequently than "distance learning" recently, especially after the pandemic, as it is a broader and more inclusive term that encompasses various forms of distance learning and instruction, including online courses, virtual classrooms, and other modes of distance-based education. The term emphasizes the idea that education can be delivered remotely, using various technologies, without requiring face-to-face interaction. In addition, the term "distance education" is more formal and established than "distance learning", and is commonly used in academic and policy contexts to refer to both distance and online learning. The term is also preferred in some regions, such as Europe, where the term "e-learning" is less commonly used. Overall, the shift towards using "distance education" instead of "distance learning" reflects the growing recognition of the diverse forms of distance learning and instruction that have emerged in response to the pandemic and the need for a more comprehensive and inclusive term to describe them.

CONCLUSIONS

The Covid-19 pandemic has had a profound impact on the education sector worldwide, leading to the adoption of online and distance learning methods. To trace the research progress and knowledge structure on this subject, a bibliometric analysis was conducted using the Scopus database covering the period of 2020-2023. The analysis revealed that 754 articles and 173 conference papers were published, with a total of 2,729 authors. Journal of Physics: Conference Series from IOP Publishing produced the most conference paper publications, and Indonesia emerged as the leader in the number of corresponding authors. The study found that "distance learning" is the most frequently used term, followed by "online learning" and "e-learning". However, in recent times, the term "distance education" is used more frequently as it covers a wider range of learning methods. The analysis also revealed that COVID-19 was the most frequently used keyword, highlighting the significant impact of the pandemic on the education sector. Other frequently used keywords were "higher education", "pandemic" and "online learning". The

analysis also identified the challenges faced by educators, including lack of access to technology, inadequate training for online teaching, and the need for increased collaboration between institutions. However, the analysis also revealed opportunities for the education sector, such as increased access to education, more flexible learning options, and the development of new technologies to support distance learning. In conclusion, this bibliometric analysis provides valuable insights into the impact of COVID-19 on distance learning, emphasizing the need for continued research and innovation in this area.

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