

# RESEARCH TRENDS OF ONLINE LEARNING IN POST-SECONDARY EDUCATION DURING THE COVID-19 PANDEMIC: A BIBLIOMETRIC ANALYSIS

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## Abstract

The Covid-19 pandemic has significantly disrupted post-secondary education with the transition to online learning, which was a mandatory teaching process during lockdowns. Despite the epidemiological situation improving, online learning is becoming increasingly popular as it provides new learning opportunities. Therefore, the paper aims to provide new insights into the trends in online learning in post-secondary education during the Covid-19 pandemic. The bibliometric analysis of 9921 documents published between January 2020 and March 2022, besides descriptive overview and scientific production, reveals the interplay between ICT tools and fields of study.

## Introduction

This paper aims to examine the trends regarding online learning, as they were influenced by the strict measures taken during the Covid-19 pandemic. The approach used for this scope is the bibliometric analysis, and it focuses on the level of post-compulsory education.

According to Donthu et al. (2021), the field of bibliometrics has been gaining popularity over the last decades for various reasons. It addresses gathering data from resources such as books and journal articles and analyzing them. Thanks to the access to such resources, there is a possibility to gather a wealth of information, findings and literature around a certain area, as well as the development of appropriate methods and practices, to manage this wealth whenever required. Bibliometrics assist in observing and viewing research progress and pointing out trends in a field, such as education or, even more specifically, online teaching. Bearing in mind that in bibliometrics, researchers can analyze a large number of articles, such as hundreds or even thousands, it is justifiable that bibliographical research is highly accurate. Indeed, researchers can this way get a cumulative

approach around a field, find out gaps in knowledge, develop ideas, and finally contribute appropriately to progress and development.

There are different ways in which bibliometric research is carried out. Any group of theorists or researchers can adopt or plan the one that fits best their project. In other words, it has not been possible so far to state the existence of an authoritative, universally accepted pattern of carrying out bibliometric research and methodology. This is largely because only recently has bibliometric analysis attracted growing interest. However, ideas about planning, such as studying in a field, can well derive from similar papers (Salini, 2016; Donthu et al., 2021).

Within this context, this research was designed. The basic goal is reached after a thorough study of the literature around bibliometrics to investigate research trends, online learning, and its research. The paper is structured as follows. After the introduction section, the next section presents a short literature review. The following section explains the materials used and the methods applied. The next section presents the main results of the bibliometric analysis. The paper ends with a conclusion in which the main findings are summarized.

## Literature Review

Bibliometrics is defined by Pritchard (1969) as “the application of mathematical and statistical methods to books and other media of communication”. Media of communication in this context include books, journal articles, monographs, theses, periodicals and, more recently, e-journals or e-books. The basic bibliometrics unit has recently become the article published in a refereed journal. Depending on the actual aim of a project on bibliometrics, it might be classified in one of the following three categories known by Glanzel (2003) as the three areas of contemporary bibliometrics.

The first is bibliometrics for bibliometricians. This field is perhaps the fundamental or perhaps the basic domain of bibliometric analysis. This area puts significant emphasis on methodology. For example, it can give important information on the methodology authors prefer and select in certain areas of study and specific topics.

The second is bibliometrics for scientific disciplines. This is important to researchers who want to investigate the massive as well as the diverse amount of communication media. This type of research can lead to the extension of information and scientific knowledge. It is influenced strongly by the orientation and interest of researchers who carry it out.

Finally, the third one is bibliometrics for management and policy. This can be referring to research, maybe of comparative nature, that addresses the national,

international or institutional level and aims to form a science-based policy. This is considered by certain bibliometricians as the ultimate type of research, emphasizing evaluation.

As concluded above, the rationale for bibliometrics lies in the necessity to evaluate the progress and the contribution of research, as well as its development. This evaluation can be based on identifying which means of research dissemination seem to be more popular or are considered to be more trustworthy. In order to do this, a measurement scale or approach will have to be designed and used. This is the basic reason why quantitative data and quantification are applied in bibliometrics. There are plenty of such scales for bibliometricians and researchers interested in bibliometrics. These have already been established and can be adopted by others when desired. However, there is also the possibility of designing and using a new one based on the specific goals or characteristics of individual projects. Parallel to the classification already described, there are others that can be used while planning studies or any kind of decision-making processes or institutions (Pacheco-Mendoza et al., 2020). Such a classification is one that distinguishes the axis of the classification or quantification, introduced by Mering (2017). This classification distinguishes between author-level metrics, article-level metrics and journal-level metrics. The first one focuses on the achievements of an individual author and the impact and response towards this person's papers and research. The second focuses on specific articles. Finally, the third one focuses on journals. In this approach, concepts such as the impact factor of the journal gain significance and have application. Each of these approaches can be achieved with the recent online measurements on websites.

During the last decades, a topic that has gained interest for researchers and bibliometricians is the implementation of online learning. The initial trigger for that phenomenon was the development of Information and Communication Technologies (ICT). This was further triggered by the outbreak of the Covid-19 pandemic, which led to the closure of education units and online and distance learning solutions. Bibliometric analysis has shown that there has been a surge in the research and articles published around e-learning over the last years. This has accompanied the significant rise of online learning courses, institutions, and opportunities. This surge has been observed globally, but it was more frequent in the developed countries of the western world. Apart from that, these studies have shown that e-learning has been approached from different perspectives. These can be the opportunities for new teaching approaches, education output, teaching material, digital skills, assessment, educational impact, challenges, and problem solving, as well as the potential to lead to further technological progress. Several suggestions have been expressed by the researchers regarding the orientation of e-learning studies. These focus on the need for an updated model combining both theoretical points and application strategies (Gao et al., 2022).

Such studies have aimed to be classified in all three areas of bibliometrics. That is because they aim to extend bibliometric research and enhance its existing models. At the same time, they aim to contribute to scientific disciplines such as Education Studies and online learning. Lastly, they aim to influence decision-making (Glanzel, 2003; Gao et al., 2022).

In that context, Zhang et al. (2022) have drawn certain conclusions regarding the impact of Covid-19 in higher education teaching research and its literature, as examined through the prism of bibliometrics. Firstly, the surge in journal articles examined has been observed in journals whose impact factor is not the highest. This is attributed to several reasons. For example, in high impact factor journals, the time needed for publication might be up to two years. Moreover, these journals do not publish many issues. In relation to that, the researchers have noticed an increase in publications which have open access or have a rapid response rate. This might be attributed to the need or the call for quick contribution to research by theorists and practitioners of online teaching in higher education.

Research projects such as the above have focused on identifying and dealing with challenges. These challenges are those that arose when online teaching was forced as a solution to the pandemic crisis. Examples can be student level and preparation, digital skills, health issues, motivation, or assessment. There is still room for further research regarding other aspects of online teaching and its implementation. These aspects might refer to preferable approaches, including approaches to assist learners with disabilities or special needs. Aside from that, there is limited research on technological progress that can lead to new, profound teaching paradigms, not only restricted to teaching activities and practices. In other words, instead of using ICT to make lessons more effective or enjoyable to students, it is useful to see if it can promote other completely new ways and ideas regarding how knowledge is constructed from its foundation (Glanzel, 2003; Zhang et al., 2022; Gao et al., 2022).

## Materials and Methods

The comprehensive bibliometric information on online learning and Covid-19 research was retrieved on 1 March 2022 from Scopus, a world-leading bibliographic database of peer-reviewed literature. The Scopus was preferred because it is considered a larger database than other competitive databases such as Web of Science (Falagas et al., 2008). This was further confirmed with the initial search using the same search query in both databases, revealing that Scopus provided more relevant documents than Web of Science. Moreover, compared to Scopus, Web of Science has been found as a database that significantly underrepresents scientific disciplines of the Social Sciences and Arts and Humanities (Mongeon & Paul-Hus, 2016). Accordingly, Scopus appears to be a

more relevant bibliographic database meeting the specifics of the online learning and Covid-19 research.

The search query covered keywords related to online learning and Covid-19 research. The search was additionally limited to the period 2020-2022 to capture the documents published between January 2020 and March 2022. Accordingly, 9921 documents were identified as eligible for further bibliometric examination on online learning and Covid-19 research.

The bibliometric analysis utilized several bibliometric approaches and software tools. The descriptive overview was conducted using the Python Data Analysis Library Pandas (McKinney, 2012) and visualized using Python Visualization Library Matplotlib (Hunter, J. D., 2007). These Python libraries were also applied to examine scientific production across countries, sources, and authors. Finally, the Jaccard index was used to examine the relationship between ICT tools and fields of study.

## Results

The descriptive overview presented in Table 1 shows the main characteristics of online learning and Covid-19 research. This research area covers a total of 9921 documents written by 33716 distinct authors listing 15228 keywords and published in 2751 sources in the period 2020-2022. Slightly less than half (46%) of these documents have at least one citation, while a relatively small number of documents (14%) were written by a single author. Moreover, the number of authors per document (3.80) in this research area is higher than in the general scientific area of Educational Research (2.70). Moreover, the average number of references per document in this research area is 32.20, which is below the general scientific area of Educational Research (44.00) (Patience et al., 2017), suggesting that online learning and Covid-19 research is grounded on a smaller number of the existing studies compared to general research. Finally, for this research area, 3.54 citations per document can be observed.

**Table 1***Descriptive overview of online learning and Covid-19 research (2020-2022)*

<b>Bibliometric items</b>	<b>Findings</b>
Timespan	2001-2022
Documents	9921
Cited documents	4593
Single-authored documents	1397
Distinct authors	33716
Sources (Journals, Books, etc.)	2751
Author's keywords	15228
Authors per document	3.80
References per document	32.20
Citations per document	3.54

The most relevant (top 10) highly-cited documents in the online learning and Covid-19 research are presented in Table 2. The most discussed topics in these documents are ICT (Chick et al., 2020; Adedoyin et al. 2020; Dedeilia et al., 2020) Pedagogy; (Rapanta et al., 2020; Murphy, 2020; García-Peñalvo et al., 2020), Health (Rundle et al., 2020; Blake et al., 2020); and Life and work (Aristovnik et al., 2020; Dwivedi et al., 2020).

As seen from the titles of articles in Table 2, the most relevant documents focus on certain topics or dimensions of online learning. A common topic that comes up in the titles is the challenges such as student level and preparation, digital skills, health issues, motivation, or assessment. Apart from that, there is a focus on the orientation and the social impact of online learning during the Covid-19 pandemic. It is also noted that the articles might examine different contexts and samples of students. Simultaneously it is also concluded that these relevant documents come mostly from developed countries. These findings can enhance the similar ones drawn from previous research projects (Glanzel, 2003; Zhang et al., 2022; Gao et al., 2022).

**Table 2**

*Most relevant documents in online learning and Covid-19 research (2020–2022)*

<b>Author</b>	<b>Year</b>	<b>Document Title</b>	<b>Source Title</b>	<b>Cited By</b>
Chick R.C. et al.	2020	Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic	<i>Journal of Surgical Education</i>	359
Rapanta C. et al.	2020	Online University Teaching During and After the Covid-19 Crisis: Refocusing Teacher Presence and Learning Activity	<i>Postdigital Science and Education</i>	339
Rundle A.G. et al.	2020	COVID-19–Related School Closings and Risk of Weight Gain Among Children	<i>Obesity</i>	307
Aristovnik A. et al.	2020	Impacts of the COVID-19 pandemic on life of higher education students: A global perspective	<i>Sustainability (Switzerland)</i>	280
Adedoyin O.B. et al.	2020	Covid-19 pandemic and online learning: the challenges and opportunities	<i>Interactive Learning Environments</i>	256
Murphy M.P.A.	2020	COVID-19 and emergency eLearning: Consequences of the securitization of higher education for post-pandemic pedagogy	<i>Contemporary Security Policy</i>	216
Blake H. et al.	2020	Mitigating the psychological impact of covid-19 on healthcare workers: A digital learning package	<i>International Journal of Environmental Research and Public Health</i>	194
García-Peñalvo F.J. et al.	2020	Online assessment in higher education in the time of COVID-19 [La evaluación online en la educación superior en tiempos de la COVID-19]	<i>Education in the Knowledge Society</i>	194
Dwivedi Y.K. et al.	2020	Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life	<i>International Journal of Information Management</i>	192
Dedeilia A. et al.	2020	Medical and surgical education challenges and innovations in the COVID-19 era: A systematic review	<i>In Vivo</i>	173

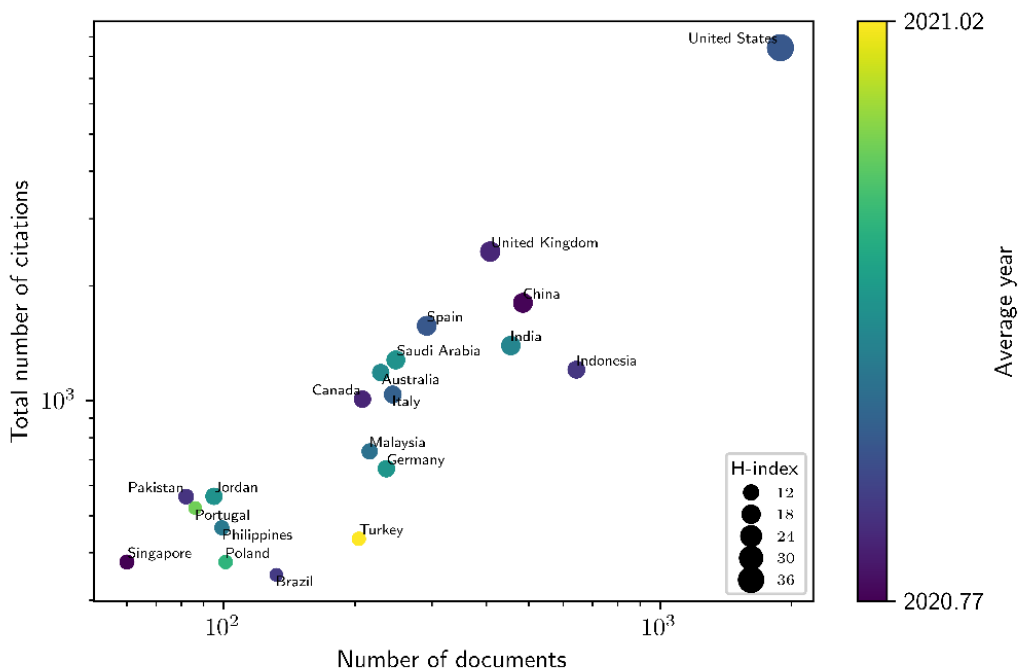
The scientific production across countries and sources is presented in terms of the number of documents and citations, whereby additional information is provided by the size of a circle, revealing the h-index as a measure of the scientific impact (Harzing & Van Der Wal, 2009) and by the colour of a circle, presenting the time dimension in scientific production.

The most relevant (top 10) highly-cited countries in online learning and Covid-19 research are presented in Figure 1. While the United States stands out among all

countries, the United Kingdom, China, India, and Indonesia also have a relatively big number of documents and citations.

**Figure 1**

*Most relevant countries in online learning and Covid-19 research (2020–2022)*

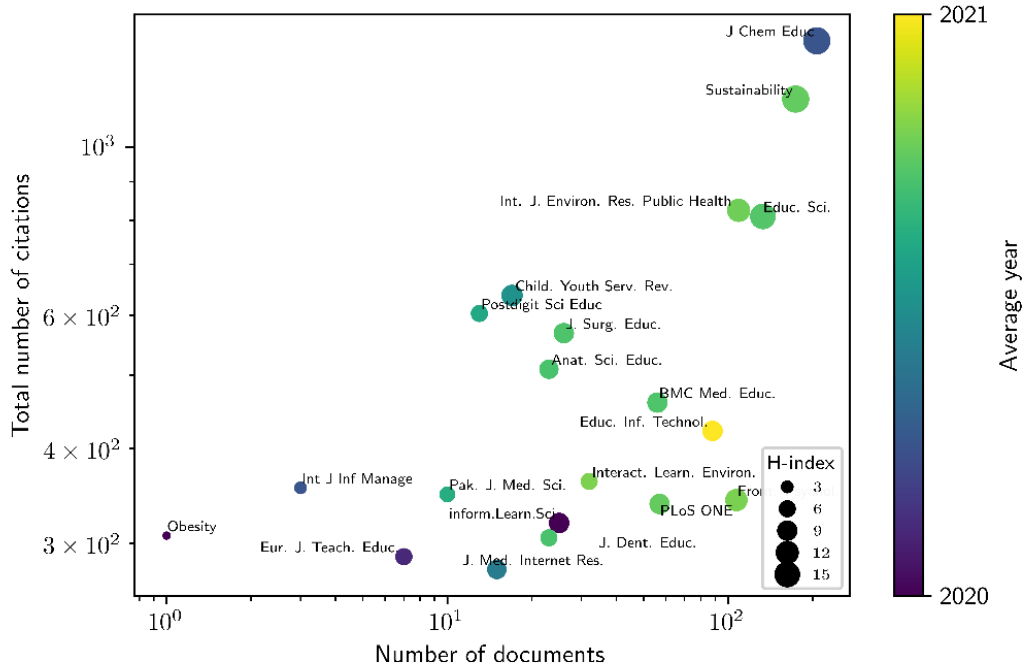


Moreover, the most relevant sources in online learning and Covid-19 research are presented in Figure 2. The most prominent sources are *Journal of Chemical Education*, having the biggest number of documents and citations, followed by *Sustainability* (Switzerland), *International Journal of Environmental Research*, and *Public Health and Education Sciences*.



**Figure 2**

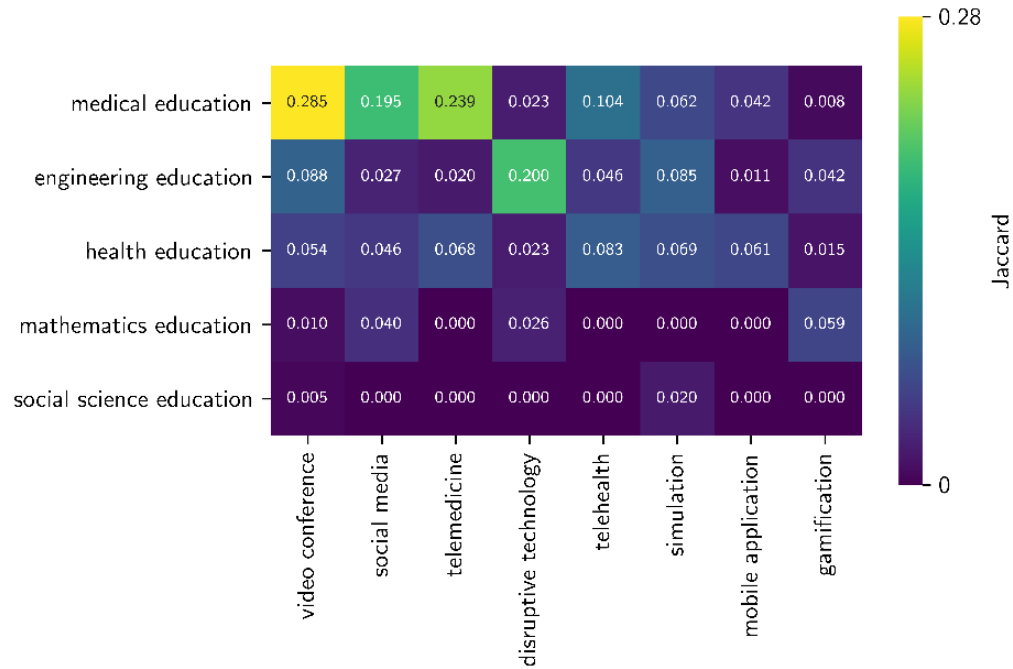
*Most relevant sources in online learning and Covid-19 research (2020–2022)*



The relationship between ICT tools and fields of study addressed in online learning and Covid-19 research is presented in Figure 3. The results of the Jaccard index based on the keywords reveal that medical education during the Covid-19 pandemic was provided predominantly through video conferences, telemedicine, and social media, while engineering education was provided predominantly through disruptive technology. Moreover, health education was provided through telehealth, followed by simulation and telemedicine, while mathematics education was provided through gamification. The ICT tools were the least exploited in social science education, as only simulation appears to be relevant in this field of study.

**Figure 3**

*The relationship between ICT tools and fields of study (2020–2022)*



## Discussion and Conclusion

This paper aims to examine the impact of the Covid-19 pandemic in the field of online learning at the level of higher or post-compulsory education. This was done through a bibliometric approach. Bibliometrics can provide significant information about the trends in a research field (Glanzel, 2003). At the same time, implementation of online learning has been increasing over the last decade, and this has accompanied a surge in research in that field, including bibliometricians. Previous studies have concluded that researchers might be focusing on certain aspects and mostly challenge the implementation of online learning (Zhang et al., 2022; Gao et al., 2022).

For the scope of the research, a total of 9921 articles were collected. These were published between January 2020 and March 2022. The contribution of this study relies on the fact that it examines up-to-date articles on the topic. Analysis was carried out with descriptive statistics and accepted tools of bibliometric studies (McKinney, 2012; Hunter, J. D., 2007).

Overall, the findings justify the trends identified in previous research studies. Covid-19 has stimulated the interest of authors in educational research in many regions around the world, although most of them seem to be from the western developed countries. The fact that the pace of references does not catch up to the average pace of papers in education research can be attributed to several factors.

An example can be the tendency of the researchers to publish in journals of high impact factor, which, as mentioned, take time to publish and do not publish many issues per year. Moreover, the fact that these even limited references have already been cited reveals that these studies are considered influential and can set the grounds that might even lead to new education paradigms in future (Glanzel, 2003; Zhang et al., 2022; Gao et al., 2022).

In short, the major trend reflected in the study is that Covid-19 certainly keeps grabbing the interest of researchers in online learning in post-secondary education. This tendency is likely to continue as probably more articles on this topic are being published (Gao et al., 2022).

Before generalizing these conclusions, it is important to point out the limitations of the study. As mentioned, it is still rather early to evaluate the impact of Covid-19 in the field of education. Nevertheless, this research probably belongs to one of the first bibliometric studies, as the methodology, as well as the conclusions, address the limitations of the existing bibliometric attempts. Future research should target a greater sample of journal articles that can aim to further and deeper goals such as policy recommendations. However, the present research can serve as a first step toward following this path (Glanzel, 2003).

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