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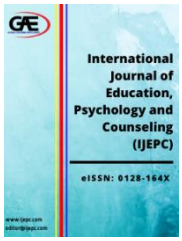

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E-LEARNING IN HIGHER EDUCATION DURING THE PANDEMIC: A SCOPUS-BASED BIBLIOMETRIC ANALYSIS

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Abstract:

This paper presents a bibliometric analysis of scholarly articles on the convergence of e-learning during the COVID-19 pandemic. It examined diverse themes, keywords, affiliations, and sources to understand the discourse surrounding online learning during the pandemic. The dataset comprised 1,261 articles extracted from the Scopus Database. Using Biblioshiny in RStudio, a bibliometric analysis was conducted, revealing key findings. The most articles (678) related to this topic were published in 2022. The United States published the highest number of articles (715), followed by Indonesia (398) and Malaysia (267). Bradford's Law identified Sustainability Switzerland as one of the valuable sources (87) of articles and h-index (13) publishing in this area. Universiti Teknologi Mara was one of the most prolific institutions, publishing the most articles (37). The word cloud analysis highlighted "COVID-19" as the most commonly used term (142 occurrences) in the literature. Thematic and conceptual structure maps offered an overview of the trends related to the research development in the field. The significance of this paper lies in its comprehensive analysis of scholarly articles through the application of the quantitative literature analysis method, explicitly employing bibliometric analysis. Exploring diverse themes and sources within a substantial dataset offers a deeper understanding of the evolving discourse in e-learning during a global crisis. Future studies could explore broader datasets, incorporating diverse disciplinary perspectives and information sources to enrich this evolving academic discourse.

Keywords:

Bibliometric Analysis, E-Learning, Rstudio, Bradford's Law, H-Index, Scopus, Quantitative

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Introduction

The occurrence of COVID-19 in December 2019 caught the world off-guard. By January 2020, the virus had spread globally, leading to a global epidemic (Azman & Abdullah, 2021). On 11 March 2020 the World Health Organization (WHO) officially declared COVID-19 a pandemic (Chaturvedi, Vishwakarma, & Singh, 2021; Meghana, Mamdapur, & Sahoo, 2021). Public health measures were implemented globally to curb the transmission of the virus, which led to unprecedented biological, sociological, psychological, spiritual, and economic challenges (Sundarasen et al., 2020).

According to UNESCO, over a billion students across 129 countries were affected by the pandemic's adverse impact on the learning process (Ryszko, 2021). Higher Education Institutions (HEIs) had to shift all their teaching and learning activities from conventional to online modes (Sundarasen et al., 2020). Universities worldwide closed their physical campuses to adhere to social distancing measures (Mahdy, 2020; Meghana et al., 2021). Although this closure demonstrated effectiveness, the abrupt transition to online learning modes presented stakeholders with a range of opportunities and numerous challenges (Owusu-Fordjour, 1i, Koomson, & Hanson, 2020; Thaheem, Zainol Abidin, Mirza, & Pathan, 2021).

This paper primarily seeks to expound upon critical findings from the bibliometric analysis of literature focused on e-learning, particularly within the broader context of the contemporary pandemic landscape. The following research questions (RQ) were formulated to achieve the abovementioned objectives.

1. What is the annual trend in literature concerning e-learning during the pandemic?
2. Which countries contributed the most to the literature on this subject?
3. What are the core sources in the field based on Bradford's law?
4. Which are the sources with the highest h-index values?
5. Which affiliations contributed to the literature on online learning during the pandemic?
6. What are the recurring themes and patterns of keywords in the literature based on:
    a) Word cloud, and
    b) Co-occurrence network analyses?
7. How has the field of e-learning during the pandemic evolved and developed over time, based on:
    a) Three-field plot,
    b) Thematic map analysis, and
    c) Conceptual structure map analyses?

Literature Review

In recent years, online learning tools have revolutionised students' learning experiences (Ilyas & Zaman, 2020). While online education has existed for decades, it has gained popularity during the past decade due to technological advancements and its benefits (Thaheem et al., 2021). Despite its familiarity with developed countries, most developing nations have not embraced e-learning before the pandemic (Ilyas & Zaman, 2020). The pandemic has drastically changed the global higher education landscape, with educational institutions worldwide being compelled to switch to online learning to ensure that students can continue their education during these challenging times (Apostol, 2020; Maatuk, Elberkawi, Aljawarneh, Hasan Rashaideh, & Alharbi, 2022). Research findings have reported that students enjoy learning

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online because of its convenience and autonomy. In addition, it has been observed that students enrolled in various online and distance education courses display higher motivation levels than on-campus students, largely because of the autonomy they experience (Kim & Frick, 2011; Rovai, 2003). However, the exigencies of the pandemic context deviated from pre-COVID circumstances, where online education constituted a choice, in contrast to the present scenario, where it has evolved into an imperative.

The following table synthesises literature on the impact of the COVID-19 pandemic on Higher Education Institutions (HEIs), focusing on the challenges faced, country responses, technological issues, and varying student perceptions of e-learning during this period.

Table 1
Synthesis Of Literature On Online Learning During The Pandemic

Topic	Findings	References
Impact of the pandemic on HEIs	HEIs struggled with the sudden transition to online learning, facing challenges such as insufficient time for transition, lack of familiarity with digital technologies, and stress among educators.	Azman & Abdullah (2021), Zobeida Salas-Pilco et al. (2022), Sia & Abbas Adamu (2020)
Country Reponses	Developed countries like France, Germany, the UK, and Australia utilized existing resources effectively. Developing countries like Nepal, India, and Sri Lanka struggled with infrastructure and resource limitations.	Dawadi, Giri, & Simkhada (2020)
Technological challenges	Issues such as internet and network problems hindered online education effectiveness, particularly in developing countries.	Thaheem et al. (2021), Chaturvedi et al. (2021)
Student perceptions (Positive)	Romanian students were highly satisfied and found e-learning improved productivity (Maier, 2020). Ghanaian students had a positive outlook on e-learning (Demuyakor, 2020). Business faculty students preferred online learning (Castro & George, 2021). 89% of Nigerian students found e-learning feasible (Hasan, 2020).	Maier (2020), Demuyakor (2020), Castro & George (2021), Hasan (2020)
Student perceptions (Negative)	Albanian students preferred conventional learning, facing technological challenges (Xhelili et al., 2021). Spanish medical science students had negative perceptions due to the	Xhelili et al. (2021), Alba-Linero (2020), Sia & Abbas Adamu (2020), Sundarasen et al. (2020), Chung et al. (2020), Yılmaz İnce et al. (2020)

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	practical nature of their studies (Alba-Linero, 2020). Other studies highlighted issues such as internet availability and connectivity problems (Sia & Abbas Adamu, 2020; Sundarasen et al., 2020; Chung et al., 2020; Yılmaz İnce et al., 2020).	
General findings	E-learning during the pandemic had mixed perceptions, with some stakeholders recognizing its productivity benefits, while others preferred conventional modes due to technological and practical challenges.	Maier (2020), Demuyakor (2020), Castro & George (2021), Hasan (2020), Xhelili et al. (2021), Alba-Linero (2020), Sia & Abbas Adamu (2020), Sundarasen et al. (2020), Chung et al. (2020), Yılmaz İnce et al. (2020)

Table 1 presents a synthesis of literature on online learning in HEIs during the pandemic. The literature reveals a dichotomy in perceptions of e-learning during the pandemic, with some students and institutions appreciating its productivity benefits, while others struggled with technological challenges and preferred conventional learning modes due to the practical nature of their studies.

Methodology

This study employed bibliometric analysis to investigate patterns and trends in the literature, using publication counts, journal impact measures, and network analyses to gain insights.

Data from the Scopus database, covering 2020 to 2023, were retrieved using the initial search query "E-learning" AND "COVID-19", supplemented with additional keywords for refinement. This search yielded 14,235 publications, of which 1,261 were deemed relevant to the research objectives. The dataset comprises seven document types: articles, reviews, notes, editorials, conference articles, book chapters, and books. Only peer-reviewed studies were included in this review. The advanced search queries are detailed in Table 2.

Table 2: Advanced Search Query on Scopus

Advanced Search Query	[TITLE-ABS-KEY ["e-learning" OR "online learning" OR "distance learning" OR "remote learning" OR "emergency remote teaching" OR "remote instruction" OR "online classes" OR "virtual learning" OR "digital education"] AND TITLE-ABS-KEY ["COVID-19" OR "pandemic" OR "coronavirus"] AND TITLE-ABS-KEY ["university students" OR "higher education" OR "college students"] AND TITLE-ABS-KEY ["learning experience" OR "student learning experience" OR "online learning experience"]
Date Range	2020-2023
Language	English
Nature of Publication	Articles

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Subject Area	Social Sciences
Relevant Records	1,261

Furthermore, the R-based Biblioshiny application was used to analyse the bibliometric characteristics of the articles, including keywords, affiliations, journals, and other attributes. The program is designed as an open-source software, allowing for extensive support from a diverse user community, including prominent statisticians who regularly contribute new functions and features (Aria & Cuccurullo, 2017).

Two relational techniques, performance analysis and science mapping, were used to examine the bibliometric attributes of the relevant literature. The performance analysis assessed the publication output by countries, authors, affiliations, and growth trends. Science mapping identified relationships among publications and analysed the research field's structure and evolution. Thematic evolution highlighted the development process of the research field and forecasted future trends. These techniques offer a comprehensive understanding of the e-learning landscape during the pandemic.

Results

This section discusses the results of the different research questions that guided this review.

Annual Publication Trend

This section addresses RQ1: What is the annual trend in literature concerning e-learning during the pandemic?

To answer this question, Figure 1 was generated based on the data extracted using Biblioshiny in RStudio. A corresponding chart was generated using Microsoft Excel.

Figure 1: Publication Frequency (2020-2024)

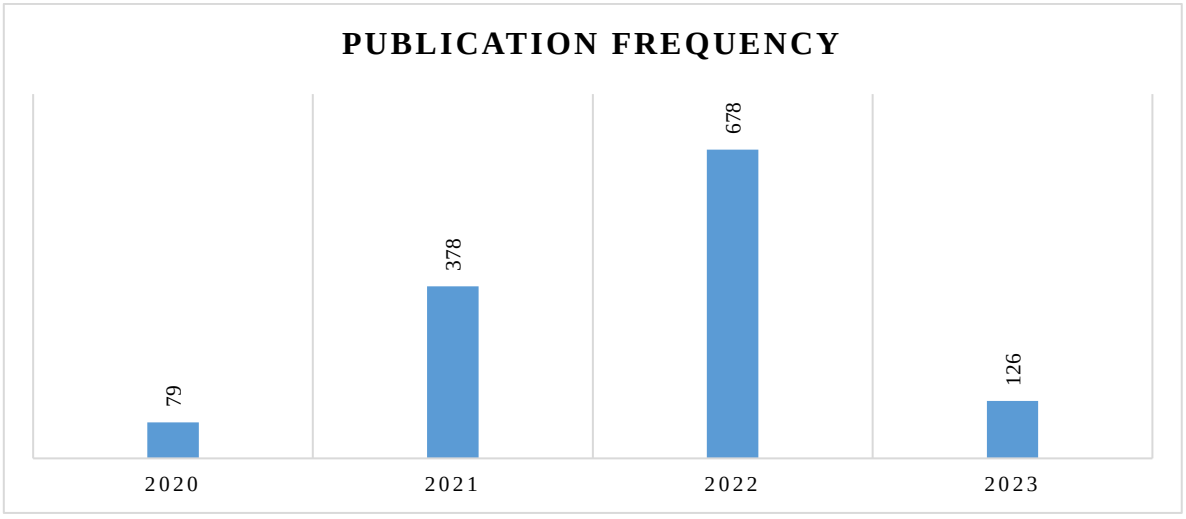

Figure 1 depicts the trend in online learning literature during the pandemic, spanning from 2020 to 2023. The dataset revealed a substantial and sustained escalation in the number of articles on this topic. Unsurprisingly, the highest number of articles on the subject was published in 2022 (678 articles). This was followed by 378 articles published in 2021 and 126 and 79 articles published in 2023 and 2020, respectively. The consistent increase in published

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articles between 2020 and 2022 indicates a substantial emphasis on e-learning research among scholars in response to the pandemic. However, a declining trend was observed in 2023, which suggests a continuing reduction in the subject's relevance as the world gradually adapted to the post-pandemic phase.

Country-wise Publication

This section addresses RQ2: Which countries contributed the most to the literature on this subject?

To answer this question, a detailed examination of the countries that published the most papers within the dataset was also conducted.

Table 3: Countries' Scientific Production

Countries	No. of Articles
USA	715
Indonesia	398
Malaysia	267
China	218
Saudi Arabia	181
UK	172
Australia	167
India	152
Philippines	94
Jordan	87

Table 3 illustrates the top 10 countries that contributed the most articles during 2020-2023. Accordingly, 715 out of 1,261 articles were authored by scholars from the United States, making it the largest contributor of published articles, followed by Indonesia (398 articles) and Malaysia (267 articles). Other countries that made substantial contributions included China (218), Saudi Arabia (181), the UK (172), Australia (167), India (152), the Philippines (94), and Jordan (87). These results demonstrate a global interest in this area and highlight the extent of international collaboration and knowledge exchange in e-learning during the global pandemic.

Core Sources as per Bradford's Law

This section discusses and addresses RQ3: What are the core sources in the field based on Bradford's law?

Bradford's Law is a bibliometric law that describes the distribution of articles in a particular field across different journals. It was first proposed by Samuel C. Bradford in 1934 and is also known as "Bradford's Law of Scattering." This law provides a framework for identifying the core journals that publish most articles on a topic, which can help researchers identify key sources while conducting research in their respective fields.

Figure 2 illustrates the distribution of articles across different sources using Bradford's law. This indicates that Sustainability Switzerland published the most on this subject, that is, 87 articles, followed by the Education Sciences journal (68 articles) and Education and Information Technologies journal (42). Other key sources included Frontiers in Education (34),

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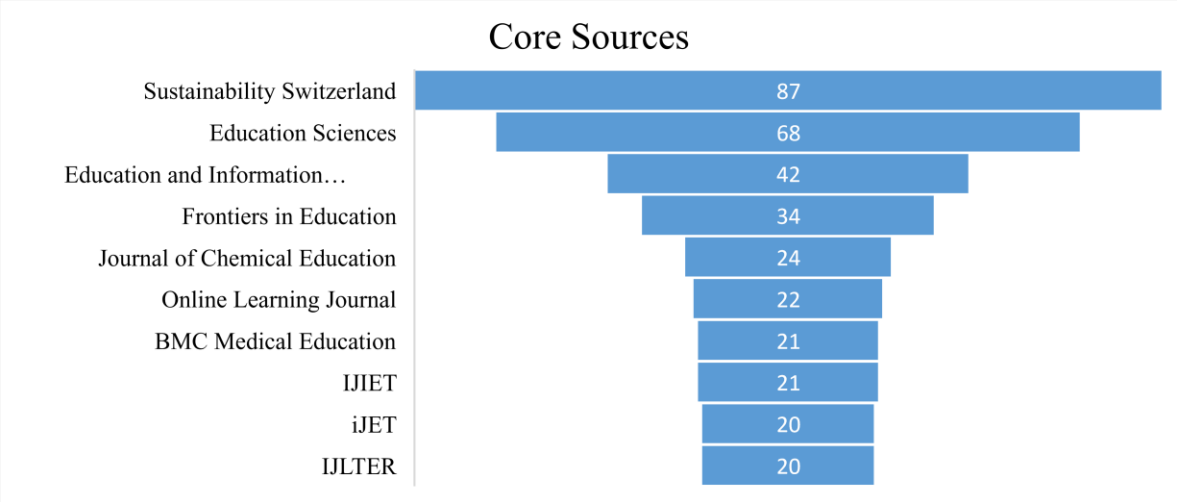
Journal of Chemical Education (24), Online Learning Journal (22), BMC Medical Education (21), International Journal of Information and Education Technology (IJIET) (21), International Journal of Emerging Technologies in Learning (iJET) (20), and International Journal of Learning, Teaching, and Educational Research (IJLTER) (20). These findings are consistent with Bradford's law, which suggests that a few highly specialised journals often publish most articles on a particular subject.

Figure 2: Core Sources as per Bradford's Law



H-Index

This section addresses RQ4: Which are the sources with the highest h-index values?

The impact of scholarly journals that published articles related to e-learning and COVID-19 was also examined. The h-index, a widely accepted bibliometric measure, was analysed to determine this. The h-index is considered a prevalent measure of scholarly performance for academic journals because of its ability to offer a more comprehensive perspective on a publication's impact, surpassing the mere scrutiny of publication or citation count (Loan, Nasreen, & Bashir, 2022).

Figure 3 illustrates that Sustainability Switzerland ranked highest, exhibiting an h-index of 13, followed by Education and Information Technologies and Education Sciences journals, with an h-index of 12, signifying their significant influence on the academic landscape. Conversely, other journals indicate h-indices ranging from 8 or lower, suggesting comparatively lower levels of scholarly impact and recognition within their respective fields.

Figures 2 and 3 indicate that certain sources impact the research domain, which differs from their expected relevance based on Bradford's law. While Bradford's law determines source relevance based on publication frequency and density, the h-index measures the scholarly significance of a source. For instance, although the British Journal of Educational Technologies is not among the top ten core sources as per Bradford's Law, the journal has a high h-index of 8 and ranks fourth on the impact measure rankings (Figure 3). Similarly, the journal Interactive Learning Environments, which is not listed in the top 10 as per Bradford's Law, indicates an h-index value of 6, ranking higher in impact measure.

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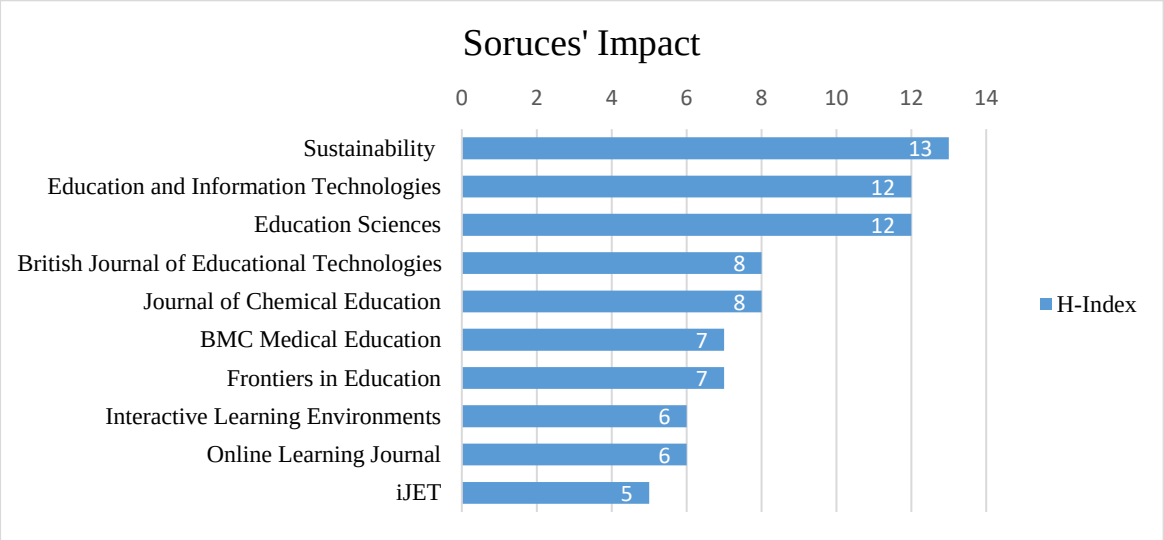
Figure 3: H-Index



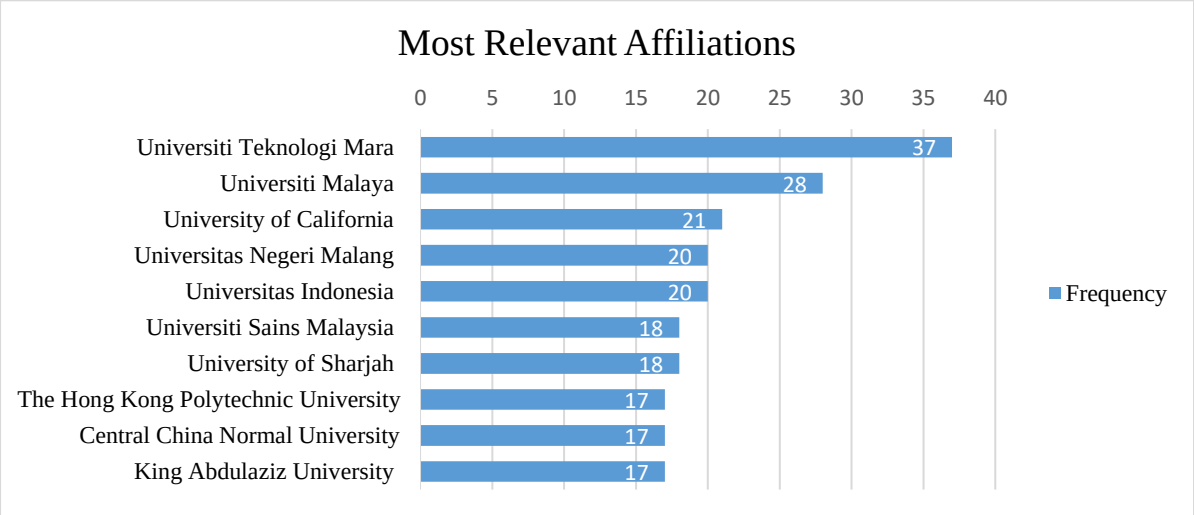
In conclusion, although Bradford's law is useful for assessing source relevance, it may not necessarily reflect their impact. These instances indicate that certain sources can substantially influence the research field more than what can be inferred from their publication count alone. Hence, the h-index provides a more nuanced and accurate measure of a publication's influence, making it a valuable tool for evaluating the relative importance of various scholarly sources.

Most Relevant Affiliations

This section addresses RQ5: Which affiliations contributed the most to literature e-learning during the pandemic?

The "Most Relevant Affiliations" data were mainly used to assess the influence of various institutions on a specific research area. Data were extracted with the Biblioshiny tool in RStudio, and a chart (Figure 4) was created in Excel.

Figure 4: Most Relevant Affiliations



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As shown in Figure 4, Universiti Teknologi Mara emerged as a leading institution in this domain, publishing 37 articles on the subject. This indicated that many articles were authored by individuals associated with the institution. Similarly, Universiti Malaya ranked second with 28 articles, followed by the University of California with 21 published articles. Other institutions included Universitas Negeri Malang and Universitas Indonesia (20 articles each), Universiti Sains Malaysia and the University of Sharjah (18 articles each), The Hong Kong Polytechnic University, Central China Normal University, and King Abdulaziz University (17 articles each).

In general, this data provide insights into the institutional landscape by identifying the most active institutions researching this area of enquiry. This information can favour researchers, funding agencies, and policymakers in making cognizant decisions on resource apportionment or identifying potential collaborative associates.

Word Cloud and Network Analyses

This section addresses Research Questions 6a and 6b.

Word Cloud Analysis

This section addresses RQ6a: What are the recurring themes and patterns of keywords in the literature based on word cloud analysis?

A word cloud was generated to visually present the most common key terms used in articles on this subject. A word cloud is a graphical representation of text data in which the most frequently occurring words are displayed with greater prominence and size, making it easier to identify the most substantial concepts in the domain (Lee & Ahmed, 2020; McNaught & Lam, 2010).

Table 4: Frequency of Keywords

Keywords	Frequency
COVID-19	142
learning	96
teaching	77
students	74
student	71
e-learning	67
education	63
human	60
pandemic	52

Table 4 displays the frequency of various keywords related to COVID-19 and education, highlighting the prominence of terms like “COVID-19,” “learning,” and “teaching” in the literature. “COVID-19” appears most frequently with 142 mentions, followed by “learning” with 96 mentions.

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Figure 5: Word Cloud

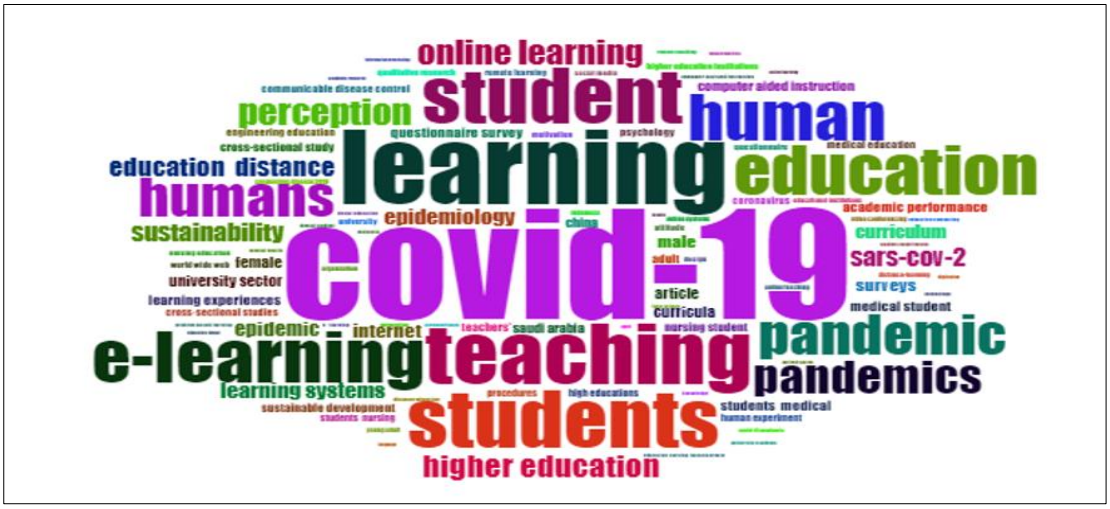

Figure 5 illustrates a word cloud generated using Biblioshiny in RStudio. The size of the words in the figure corresponds to the frequency with which they appear in the articles across all sources. Therefore, the more frequently a term is used in an article, the larger and more prominent it appears in the word cloud. While the placement of the words in the cloud is arbitrary, the most vital terms are generally positioned toward the centre of the cloud to ensure their visibility. Accordingly, it can be observed that terms such as 'e-learning', 'teaching', 'students', 'education', and 'perception', among others, were widely studied in this context.

Co-occurrence Network Analysis

This section addresses RQ6b: What are the recurring themes and patterns of keywords in the literature based on co-occurrence network analysis?

Co-occurrence network analysis is a widely employed technique in bibliometric analysis to identify key research areas and emerging trends within a scholarly field by quantifying the frequency of co-occurrence of keywords in pairs across academic literature (Aar, 2022). This method enables researchers to identify important concepts, patterns, and research topics in a given field through network visualisation. It involves detecting clusters of associated terms or concepts that indicate their co-occurrence across multiple publications from different sources.

Figure 6 presents a co-occurrence network using Biblioshiny in RStudio, highlighting three prominent clusters of frequently used keywords in the dataset. The first major cluster included keywords such as "COVID-19", "teaching", "education", "learning", and "student", indicating that the articles primarily focused on the pandemic's impact on education, teaching, students, and learning. These keywords suggest that researchers explored the pandemic's challenges and opportunities in these educational aspects. Additionally, the network shows connections to "higher education", "university sector", and "academic performance", implying a focus on overall academic performance and learning outcomes across various higher education levels.

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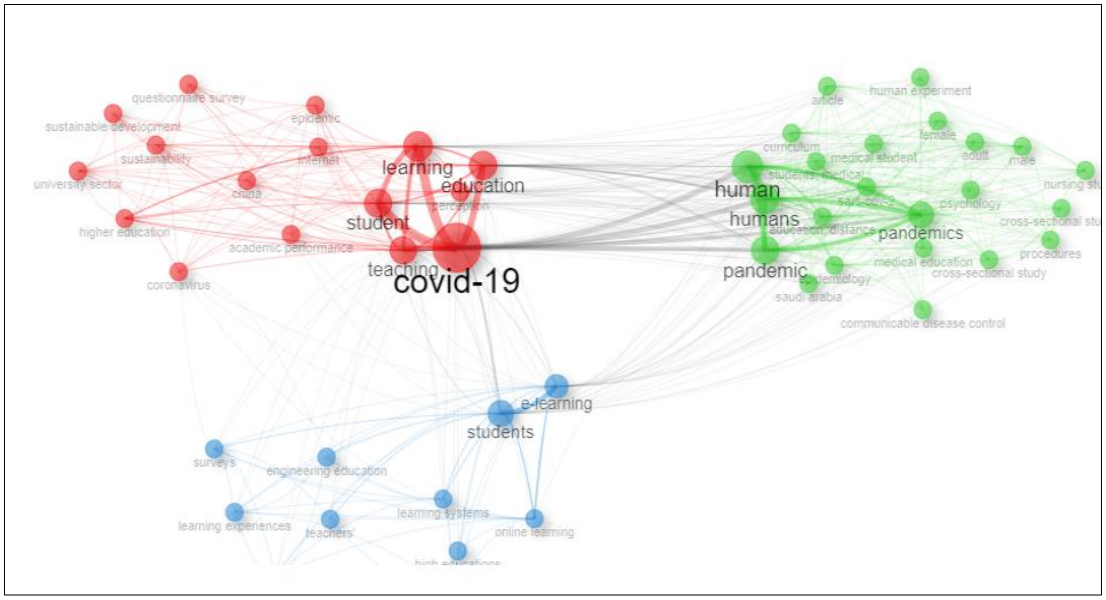
Figure 6: Co-occurrence Network Analysis



The second major cluster comprises closely connected keywords such as “medical student”, “humans”, “pandemic”, “medical education”, “psychology”, and “nursing studies”, highlighting a strong emphasis on the medical and healthcare sciences. The presence of “medical student” and “medical education” indicates significant attention to medical science students, while “humans” and “pandemic” reflect the global health crisis explored by scholars in this field.

The third cluster is defined by keywords such as “e-learning”, “students”, “teachers”, “learning experience”, and “learning systems”, indicating a focus on technology-based learning. This is especially relevant during the pandemic, which necessitates a shift to online education. The terms “students”, “teachers”, and “learning experience” highlight the impact of e-learning on both groups, while “learning systems” emphasises the technological infrastructure supporting e-learning. This cluster underscores the importance of research in educational technology, particularly during the pandemic, when e-learning became essential.

Themes and Patterns Analyses

This section addresses Research Questions 7a, 7b, and 7c.

Three Field Plot Analysis

This section addresses RQ7a: How has the field of e-learning evolved and developed over time during the pandemic, based on three-field plot analysis?

Bornmann and Leydesdorff (2014) defined a three-field plot as a scatter plot, with three axes representing specific aspects of a dataset. These interrelated dimensions provide valuable information on various factors, such as sources, authors, affiliations, and keywords. The plot visually represents these factors and their relationships, making it a useful tool for bibliometric analysis. The interdependence of the dimensions in the plot allows for a proper understanding of the data, revealing patterns and trends in literature. Figure 7 presents a three-field plot generated using Biblioshiny in RStudio.

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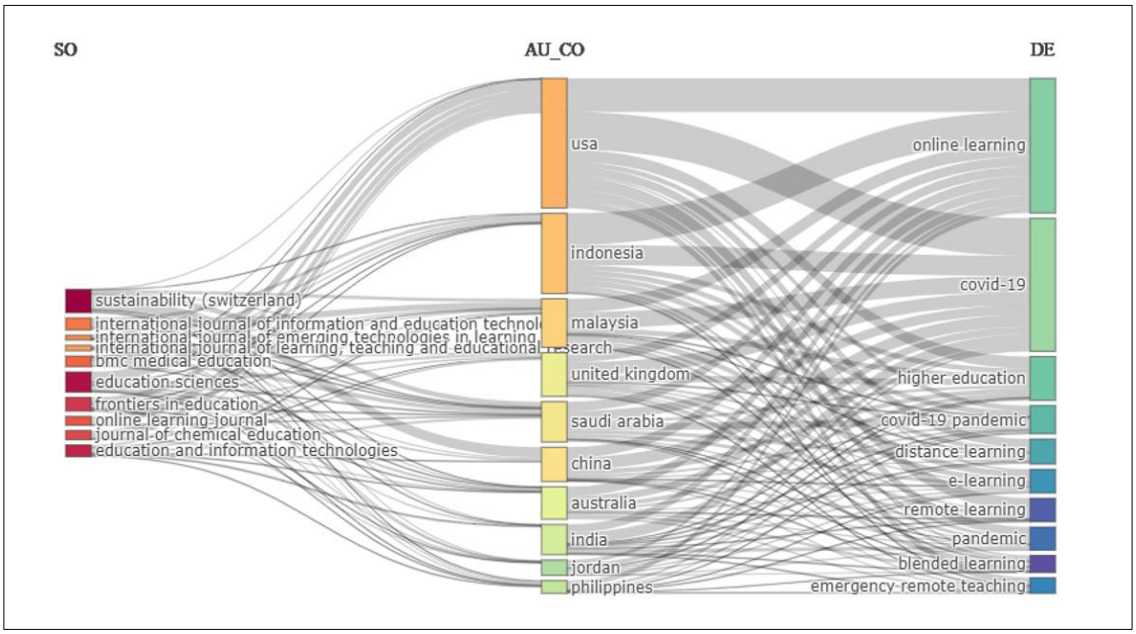
Figure 7 depicts the interconnection of three crucial components, namely, sources (SO), authors' countries (AU_CO), and keywords (DE), through gray linkages to demonstrate their relationships. The links begin with SO, followed by AU_CO, and culminate in links to DE in their research articles. The size of each rectangle corresponded to the number of associated research articles.

The plot indicates the top journals that published the most online learning articles during the pandemic. The leftmost axis of the plot displays the top ten indexed journals in this domain. The central axis depicts the top ten nations contributing to this literature. Finally, the rightmost axis offers insights into the primary topics and themes of the investigation.

Figure 7: Three-Field Plot



The top journal publishing the most articles was Sustainability Switzerland, positioned highest on the left side of the plot, indicating an 'outgoing flow count' of 10. This means authors from ten countries, including the US, Indonesia, Malaysia, the UK, Saudi Arabia, China, Australia, India, Jordan, and the Philippines, have published in this journal, demonstrating its international reach and credibility.

The rightmost axis of the plot displays the keywords used in the articles. Among several keywords, "online learning," "COVID-19," and "higher education" appeared most frequently, indicated by the larger size of their corresponding boxes. Other frequently appearing keywords included "distance learning," "e-learning," "blended learning," and "emergency remote teaching," highlighting the focus on e-learning and the pandemic in scholarly literature. The prevalent use of these keywords reflects the shift to remote education, while "emergency remote teaching" underscores the sudden transition to online modes and the challenges faced by educators.

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In summary, the three-field plot highlights the top journals, international representation of contributing authors, and the most frequently used keywords, offering insights for further research.

Thematic Map and Data Evolution

This section addresses RQ7b: How has the field of e-learning evolved and developed over time during the pandemic based on thematic map analysis?

Figure 8: Thematic Map

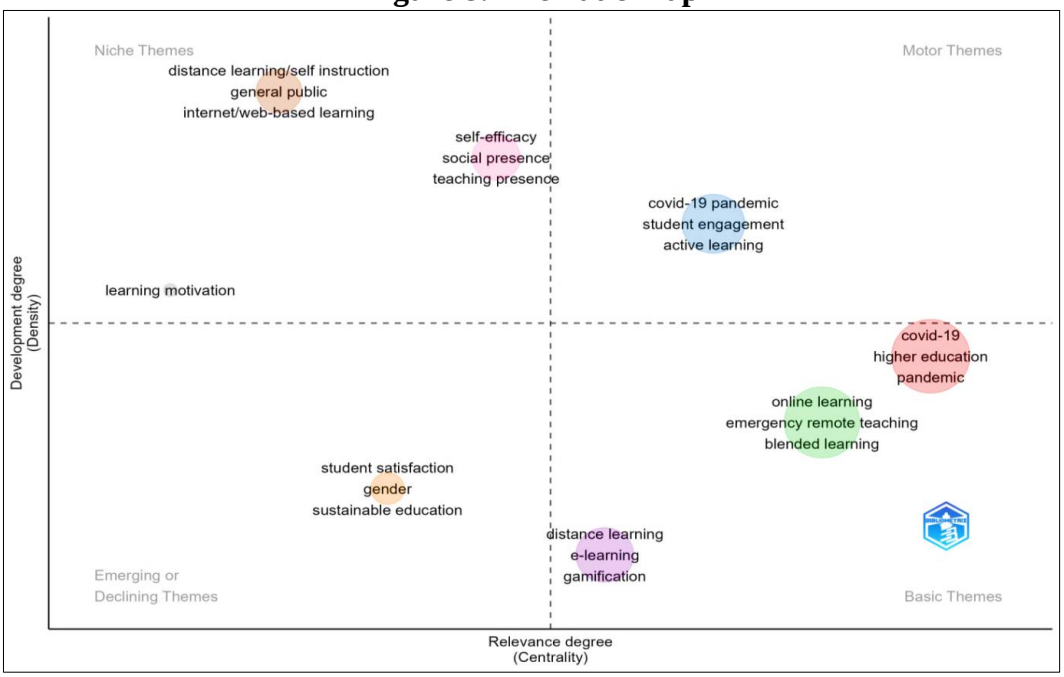

Figure 8 displays the distribution of the bibliographic data in terms of density and centrality. The upper right quadrant in the map represents “motor themes”, characterised by high density and centrality. These are also called “mainstream research themes” (Giannakos, Papamitsiou, Markopoulos, Read, & Hourcade, 2020). Thus, the themes included in this quadrant are considered highly influential and have a major impact on the direction and focus of research within a field. This quadrant included articles with keywords such as “COVID-19 pandemic,” “student engagement,” and “active learning.” Recognising these themes highlights the significance of the existing literature and underscores the need to explore aspects such as student engagement and active learning in e-learning contexts. Thus, motor themes are crucial for understanding current research and guiding future research directions within a field.

Conversely, the top-left quadrant represents “niche themes”, marked by high density but low centrality, indicating their under-representation and potential for rapid development. The articles here are well-structured internally but weakly connected to other research clusters. Keywords in this quadrant, such as “distance learning”, “self-efficacy”, and “learning motivation”, suggest high relevance within specific education sub-fields, such as online learning or distance education. However, their limited connection to broader research networks means that they are influential within their niche but may lack broader impact. These themes can serve as a foundation for further exploration of more general research areas.

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The lower left quadrant, representing "emerging or declining themes", includes topics that have experienced a downward trend, indicated by low centrality and density. Keywords such as "student satisfaction", "sustainable education", and "gender" signify areas needing renewed attention and revitalisation. Identifying these declining themes highlights the necessity of rejuvenating them with fresh perspectives and innovative approaches.

Conversely, the lower right quadrant, denoting "basic themes", contains topics with high centrality but low density, indicating their vital relevance and strong linkage to other research themes. However, the number of articles on these topics has decreased over the years. This quadrant includes keywords like "e-learning", "emergency remote teaching", and "higher education", which were highly pertinent during the pandemic-impacted educational climate. The decline in these themes suggests the need to re-examine and invigorate research in these areas.

In summary, thematic maps are valuable for analysing bibliographic data and identifying research trends. By considering density and centrality, researchers can understand the distribution and development of the different themes in a dataset. Insights from the quadrants can guide future research towards areas needing revival or re-examination, as well as those of rapid development or high relevance. Thematic evolution is another visualisation tool in Biblioshiny that enables researchers to identify trends in research publications. It analyses the development of primary research areas over time, using two key dimensions, centrality, and density, to identify evolving research themes (Ryszko, 2021). This tool provides insight into the current state and sustainability prospects of the field. By disseminating information on existing, past, and future trends within a given domain of interest, this analysis offers valuable insights to researchers and stakeholders alike (Agbo, Oyelere, Suhonen, & Tukiainen, 2021).

Figure 9, generated using Biblioshiny in RStudio, illustrates the thematic evolution of themes related to online learning and COVID-19 from 2020 to 2023. The box sizes in the network diagram denote the relative frequency of publications, whereas the links between nodes indicate the degree of co-occurrence in the same publication. The data reveal the emergence of themes like "online learning", "e-learning", "distance learning", and "COVID-19" between 2020 and 2022. Although online learning remains relevant in 2023, its significance has declined, as shown by the reduced density and size of the nodes in Figure 10. This decline corresponds to the global transition to the post-pandemic phase, prompting researchers to explore other areas of interest. Consequently, these themes are no longer the primary research focus.

In 2022, "remote learning" became a key focus, as indicated by its prominent node size and density. Researchers also extensively examined themes like "social presence," "learning engagement," and "e-learning." Notably, "social presence", a dimension of the online learning experience defined by Garrison et al. (2007; 2017, 2022) under the community of inquiry framework, has been explored in various pandemic contexts (Erickson & Wattiaux, 2021; Tan, 2021; Zulkanain, Miskon, & Syed Abdullah, 2020). Despite being smaller, the theme of "social presence" remains relevant and unique.

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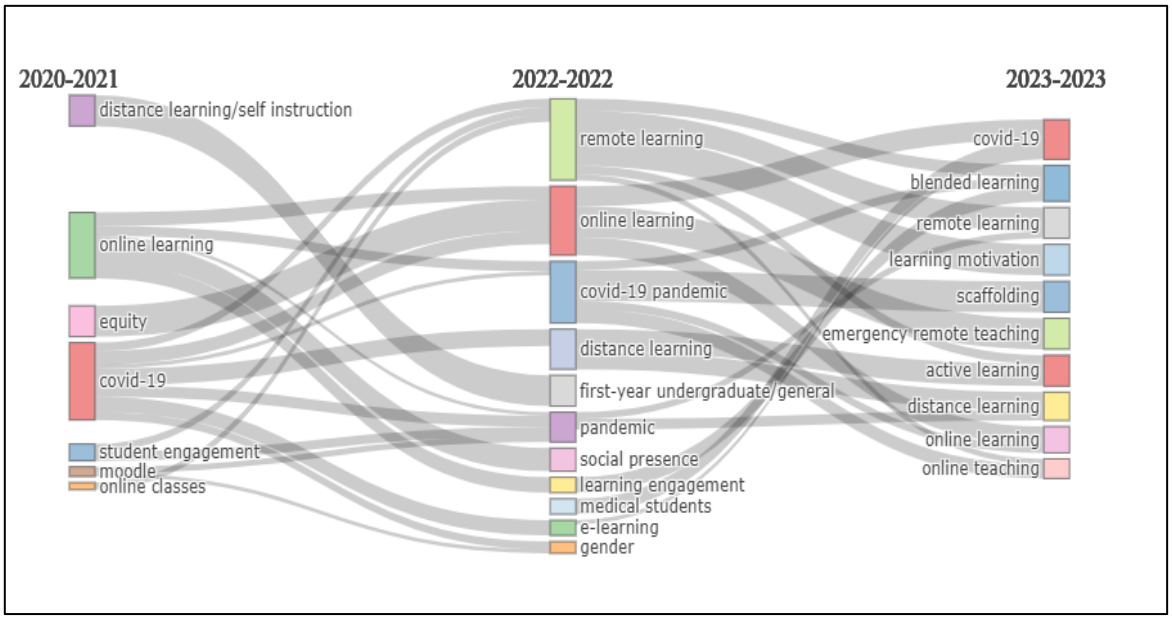
Figure 9: Thematic Evolution Data



By 2023, interest appeared to be evenly distributed among various themes. “Blended learning” and “remote learning” have gained prominence over “online learning”, which has been more prevalent in previous years. Researchers have also delved into “learning motivation” and “scaffolding.” The rise of “blended learning” and “remote learning” in 2023 reflects the evolving educational landscape post-pandemic, while the focus on “learning motivation” and “scaffolding” indicates an effort to enhance the quality of students’ online learning experiences, thereby improving engagement and success in virtual environments.

Conceptual Structure Map

This section addresses RQ7c: How has the field of e-learning evolved and developed over time during the pandemic, based on conceptual structure map analysis?

A conceptual structural map was generated using Biblioshiny in RStudio. The map visually represents the relationships between frequently occurring words in the given dataset, as shown in Figure 10. The placement of each word on the map was determined by the values of Dim 1 and Dim 2, which are diminutive particles in bibliometric science. This technique condenses complex datasets with numerous variables into a simplified, two-dimensional (or three-dimensional) graph that uses proximity to represent keyword similarity (Meghana et al., 2021). Keywords positioned closer to the centre signify higher levels of attention in recent times (Xie, Zhang, Wu, & Lv, 2020). This approach generated a conceptual structure map to provide a clear and concise visualisation of the relationships between words within the context of e-learning and COVID-19 research.

This map was deployed to explore the co-occurrence patterns of words to identify major themes and areas of research focus during the pandemic. The map was divided into four quadrants and two main clusters. The identification of two primary clusters suggests that co-occurring words can be classified into distinct groups based on their underlying characteristics.

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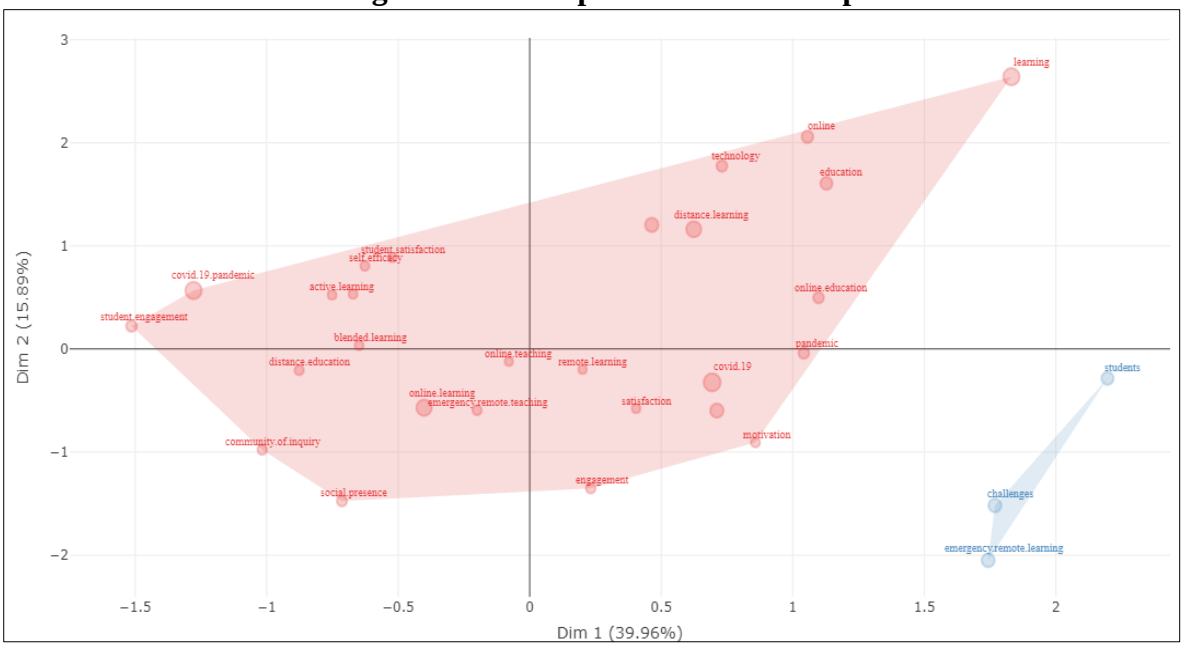
As seen in Figure 10, the larger cluster, which contains 23 major themes, is found to include several important topics, such as "online learning," "emergency remote teaching," "distance learning," "technology," "student satisfaction," "student engagement," "online education," and "motivation." These themes highlight the importance of technology and remote learning in the face of the pandemic and the need to ensure student satisfaction and engagement in online learning environments.

Figure 10: Conceptual Structure Map



The smaller cluster, on the other hand, includes three major themes, namely "challenges," "emergency remote learning," and "students." This highlights the challenges posed by the pandemic in the context of emergency remote learning, particularly for students.

The theme "challenges" may likely encompass many issues, such as technological challenges, access to resources, and the difficulties associated with transitioning to online learning. This is supported by the fact that the theme is included in this cluster, suggesting that these challenges may be distinct from the topics covered in the larger cluster. The theme "emergency remote learning" also underscores the urgency of the shift to online learning during the pandemic. This theme may encompass issues related to the rapid implementation of online learning technologies and strategies and the challenges associated with transitioning to a new mode of instruction. Finally, the theme "students" suggests a focus on the perceptions and experiences of students. This may include considerations such as student engagement, satisfaction, and achievement, as well as issues related to equity and access to education.

Identifying these major themes within different clusters reveals the opportunities and challenges of e-learning during the pandemic. Highlighting the issues faced by educators and students, this analysis can inform effective remote instruction strategies and support the continued delivery of high-quality education during difficult periods.

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Discussions and Conclusions

Bibliometric analysis was conducted using Biblioshiny and R Studio. The analysis utilised a carefully refined dataset extracted from Scopus, focusing on journal articles related to e-learning and the COVID-19 pandemic.

The pandemic has emerged as a globally impactful phenomenon that has attracted the attention of researchers across numerous fields, including education. During this time, the literature was largely preoccupied with e-learning as a potential solution to the challenges presented during that time. Thus, the results demonstrate that research on this subject has been widely published by various academic journals, with numerous authors contributing to this domain.

Accordingly, Bradford's Law revealed that Sustainability Switzerland, the Education and Information Technologies Journal, and the Education Sciences Journal were the most impactful research sources. Sustainability Switzerland was the most prolific journal. Notably, this journal is also one of the high-impact journals, with the highest h-index of 13, indicating that it has published many highly cited articles on this subject. Therefore, based on the findings of this analysis, it can be concluded that these are some of the most dominant and influential sources on this subject. Researchers seeking references could consider these journals as essential resources for their inquiry.

The word cloud analysis revealed key themes with primary and secondary focus on different aspects of online learning. Furthermore, the co-occurrence network analysis highlighted widely used words in literature. This diversity suggests that discussions on online learning covered a broad range of themes, including sustainability, student and educator perceptions, and implementation in the university sector. Researchers could find valuable references related to these themes in the literature.

The three-field plot provided insights into frequently explored subjects, productive countries, and influential journals within the field. Meanwhile, the thematic map depicted the development of e-learning research during the pandemic. By categorising bibliographic data into quadrants based on density and centrality, researchers can identify relevant subjects and recognise under-researched areas that may need further exploration.

Finally, the conceptual structure maps detailed interrelationships between keywords, offering a nuanced understanding of their connections in the research. Overall, these findings contribute to a comprehensive view of e-learning research conducted during the pandemic.

Limitations and Recommendations

The following section outlines several limitations that warrant consideration when evaluating the outcomes and implications of this study.

First, the scope of the study was limited to articles published on the themes of e-learning and the COVID-19 pandemic, which may only partially capture part of the spectrum of research in online education. In addition, only articles from the field of Social Sciences were included, potentially excluding literature from other fields. Moreover, the study used limited bibliometric analyses, such as three-field plot, Bradford's law, h-index, word cloud, thematic map, co-occurrence network, and conceptual structure map analyses.

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It is also pertinent to note that the review is limited to data collected from the Scopus database from 2020 to 2023. Finally, although bibliometric analysis provides valuable insights into research patterns and trends, it does not necessarily capture the quality or impact of individual studies. Therefore, future researchers could explore other avenues for reference, advancing this vital enquiry area.

Accordingly, future studies could expand the scope beyond e-learning and the COVID-19 pandemic, and include articles from fields other than Social Sciences. This provides a broader understanding of online education. Incorporating additional bibliometric analyses, such as author productivity, citation networks, and Lotka's law, could provide a deeper understanding of the research landscape. Furthermore, using diverse databases and extending the study period beyond 2020-2023 would enhance the robustness of the findings. Future research should also focus on assessing the quality and impact of individual studies to complement bibliometric insights.

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