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Mapping the Development of E-Learning-Based Learning During and Post-COVID-19 Pandemic (2020-2024) with Bibliometric Analysis

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Abstract

This research aims to map the development and direction of educational research in Scopus-indexed publications. This study uses bibliometric analysis techniques to explore all journals indexed in the Scopus database on E-learning from 2020 to 2024, namely during the pandemic - post-Covid-19 pandemic. The data was analyzed using Excel and R / R-Studio. VOSviewer is used to visually analyze the emergence of keywords and document citations simultaneously. The author found 4510 publications that match the functions, subjects, and criteria set. The results of this study show the most publications on E-learning in 2023. The United States is the country that contributes the most publications, with an affiliation from the University of Florida. Hwang G. J is the most productive author on the E-learning theme. The bibliometric analysis conducted is limited to Scopus data. Other national and international databases are not taken into account in this study. This study presents a brief overview of the literature that researchers can access in the field of education and provides recommendations for future research.

Keywords: Bioindicators, E-learning, Education, Covid-19

Introduction

In 2020, precisely at the beginning of the year, various countries in the world, especially Indonesia, were shocked by an incident that made people restless, namely the presence of a virus known as the coronavirus or COVID-19 (Siahaan, 2020). The increase in the number of COVID-19 cases is relatively rapid, and there has been spread between countries. The Indonesian Ministry of Health noted that as of March 25, 2020, the total number of confirmed cases was 414,179, with 18,440 deaths (CFR 4.4%) where cases were reported in 192 countries/territories. Several health workers have been reported to be infected (Putri, 2020). One of the methods used to implement social distancing is by working from home or "Work From Home" (WFH) (Tuti, 2020). The WFH policy is implemented in all fields, including education. The Minister of Education also invites teachers and lecturers to work from home or work from home. Nadiem said teaching activities can be done from home using technology (Purwanto, 2020).

The online system in the learning process uses e-learning (Nurkholis et al., 2020). Technology as a learning tool can be used in applications such as Zoom, Google Meet, LMS (learning management system), Google Classroom, and many others (Komalasari, 2020). Distance learning with e-learning can generally provide understanding to students in the same way as conventional face-to-face learning (Harianai et al., 2020).

It is very important to critically analyze existing research findings to pave the way for further research and provide projections as suggestions for Muhammadiyah on areas needing a more significant portion of accelerated development. This evaluation procedure is highly dependent on the availability of data from scientific research activities and the accuracy of the data.

Bibliometric indicators are one of the tools that play a role in evaluating the results of scientific research, studying the interaction between science and technology, producing a mapping of scientific fields, tracking/tracing the development of new knowledge in a particular field, and are future indicators in making strategic plans (Belmonte etal., Boquera et al., and Zheng et al., 2019).

This study aims to map the development and direction of Muhammadiyah's research in publications indexed in the Scopus database from 1995 to 2022. 1995 was chosen as the starting year based on findings in the Scopus database, which found that the first two publications about Muhammadiyah were found in that year.

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Literature Review

Learning from home through online/distance learning is carried out to provide meaningful learning experiences for students without the burden of demands to complete all curriculum achievements for class promotion or graduation (Dwi et al., 2020). Research conducted by Erna states that learning with E-Learning online requires a management system in learning to make it easier for teachers and students to enter the class as a substitute for the classroom (Pujiasih, 2020). Students' learning styles in online learning tend to be more visual and stronger in reading and writing, with many platforms that support them for free, such as Google Classroom, Whatsapp, Quipper, etc. (Husain et al., 2021).

Diniati's research presents the findings of classroom action research obtained by implementing Google Classroom, which can increase student motivation and learning outcomes (Danianti et al., 2020). Using E-Learning applications other than Google Class Room is chatbots, teachers believe that chatbots add a greater level of social presence, which ultimately creates an environment for their students to be active (Nurkholis et al., 2020). Another application is Zoom Meeting; Danin's research shows that the Zoom Meeting application is not very effective for students at universities in Jakarta and Depok. However, the Zoom Meeting application is better because, in the Zoom Meeting application, communication between individuals is carried out verbally compared to the use of learning applications that carry out communication activities in writing according to educational communication theory (Haqien et al., 2020).

The implementation of distance learning due to the Covid-19 pandemic has advantages and disadvantages, based on Firmansyah's research, the results of student responses show that there are advantages and disadvantages in implementing online learning at SMA Wahidiyah Kediri. The benefits of online learning are that learning can be done anywhere and anytime, training students' learning independence, more varied learning, more expansive learning resources, and saving time, money, and energy. The obstacles in the implementation of online learning are weak internet connections or networks, especially in certain areas; the need for large internet quotas; low abilities in terms of information and technology (IT) from both teachers and students; and the design of the online learning model is not yet appropriate so that students have difficulty understanding the material. The disadvantages and obstacles in implementing online learning are more dominant, so students' learning motivation is low (Firmansyah, 2021).

Method

Method bibliometric analysis was used in this study. Data were obtained using a Boolean search engine to comb the Scopus database between 2020 and 2024. The search was conducted on December 15, 2023 at 15.00 WIB. Researchers used R and Rstudio tools, VosViewer, and Microsoft Excel to analyze citations, document content, and networks. Researchers took three stages in processing the dataset.

In the first stage, researchers will conduct a literature review on related themes to ensure relevant research is carried out with bibliometric topics. In addition, a literature review is useful for determining appropriate keywords and is considered to be able to represent the scope of the research.

Second stage: At this stage, the researcher uses Boolean operators TITLE-ABS-KEY (sustainable AND finance) to search on Scopus, which resulted in 123,252 documents. Furthermore, filtration was performed using the *boolean* operator TITLE-ABS-KEY(e-learning) AND PUBYEAR > 2019 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (EXACTKEYWORD, "E-learning")) AND (LIMIT-TO (SUBJAREA, "SOCI")) to limit only articles as the type of article document, document sources only journals and only English-language articles, resulting in a final document of 4510.

The third stage, Analysis, was carried out on the final search documents using Scopus analyzer and R and Rstudio to find the number of documents per year, documents by journal, author, affiliation, country, and subject/field. Furthermore, analysis is carried out on the document network level with visualization through VOSviewer and Microsoft Excel data processing. The research procedure can be seen in Figure 1 below:

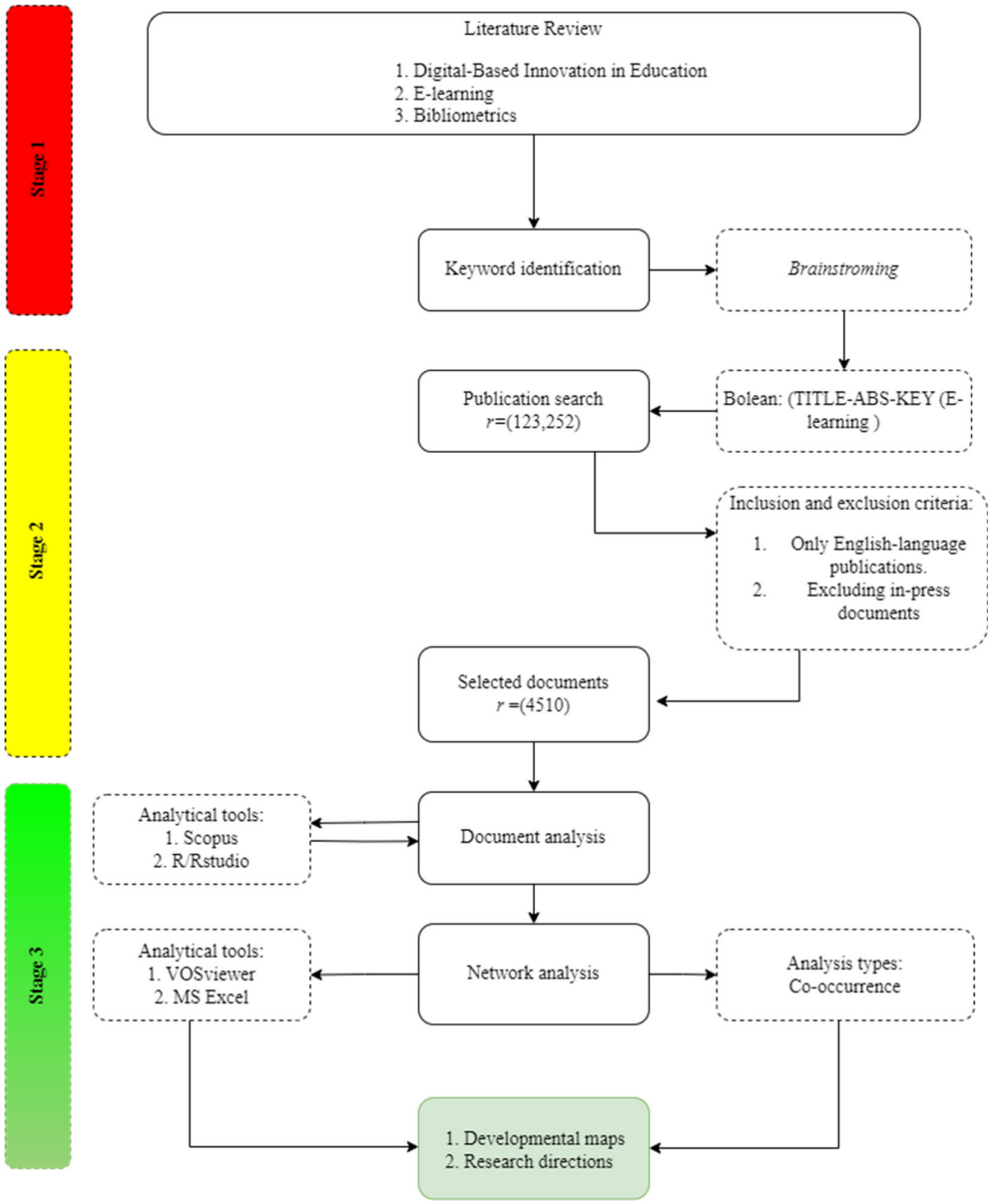

Figure 1. Research Workflow

Results and Discussion

Key Information About Data

Table 1 provides an overview of the 4510 documents collected over 5 years. This includes 12988 authors, 510 single authors, 21.44% international authorship collaboration, and 197937 references, with an average citation per document of 9,447 citations.

Table 1. Main Information

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2020:2024
Sources (Journals, Books, etc)	624
Documents	4510
Annual Growth Rate %	-58.28
Document Average Age	1.28
Average citations per doc	9,447
References	197937
DOCUMENT CONTENTS	
Keywords Plus (ID)	14106
Author's Keywords (DE)	10271
AUTHORS	
Authors	12988
Authors of single-authored docs	510
AUTHORS COLLABORATION	
Single-authored docs	550
Co-Authors per Doc	3.5
International co-authorships %	21.44
DOCUMENT TYPES	
articles	4510

Documents By Year

Figure 2 shows the development of publications in the E-Learning theme by year. Data according to the E-Learning theme with a period of 5 years. Data from 2020 to 2023 experienced an increase of 792, 1066, 1292, and the last 1336 in 2023. In 2024, it had 24 documents.

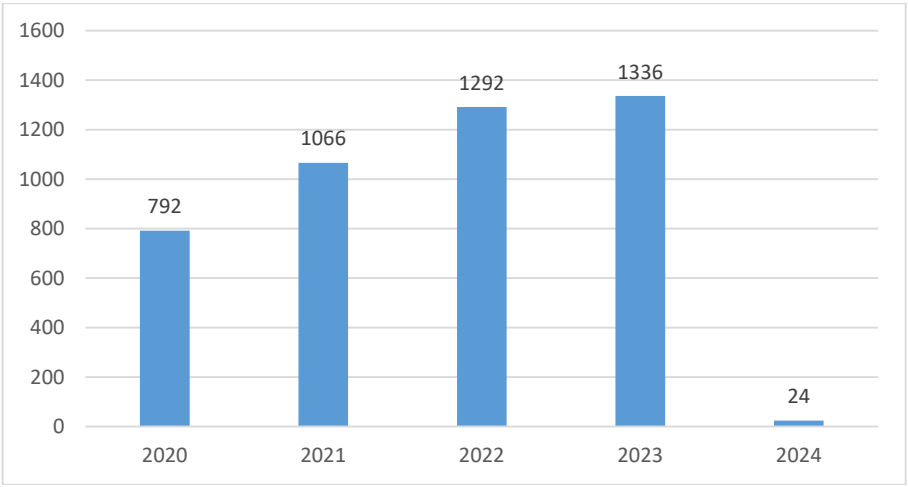

Figure 2. Analyze by Year

Most Relevant Authors

Figure 3 shows the ten most influential authors in publications on E-learning. Hwang, GJ leads with 25 publications, followed by Makransky and Tsai with eight each. Li, Lopez-Pernas, Mayer, Ritcher, Santoso, Saqr, and Xu, with seven each.

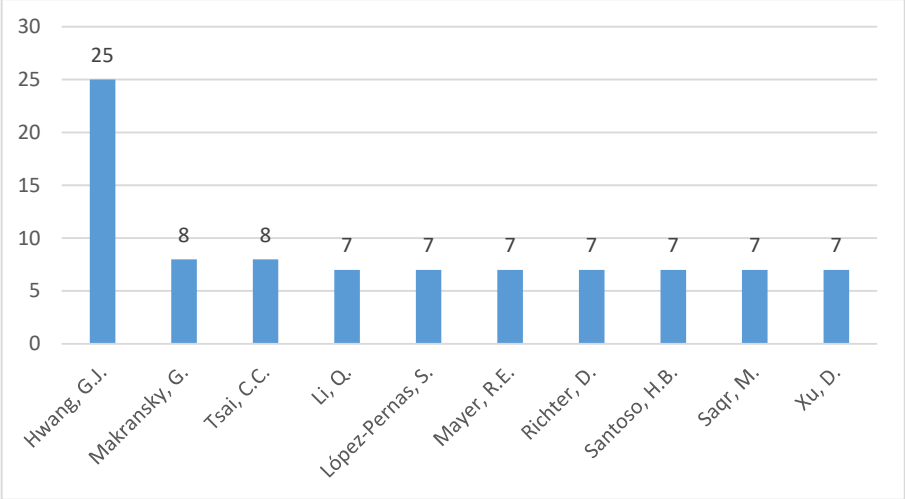

Figure 3. Analyze by Author

Documents By Affiliation

Figure 4 shows the 10 most influential affiliates in publications on E-learning. University of Florida with a total of 35 publications. National Taiwan University of Science and Technology with 34 documents. Purdue University and Kazan Federal University have 33 documents each. Sechenov First Moscow State Medical University with 31 documents. Central China Normal University and Beijing Normal University have 29 documents each. Malang State University with 24 documents. Next are King Abdulaziz University University and The University of Hong Kong, each with 23 documents.

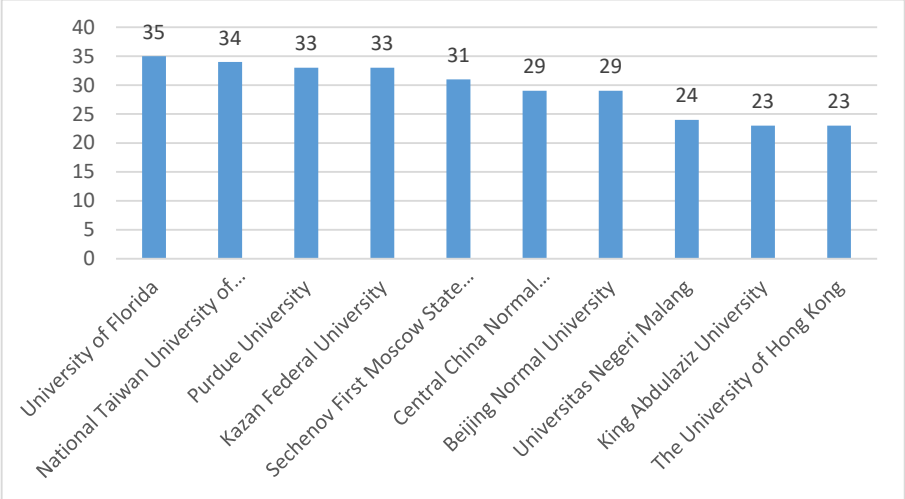

Figure 4. Analyze by Affiliation

Documents By Country

Figure 5 shows publications by country with the theme of E-Learning. America leads the publication with a total of 714 documents. Followed by China with 695 documents.

Asian continent countries dominate with four countries, while European continent countries are in second place, this shows that research with the theme of E-Learning is popularly conducted by countries on the Asian continent.

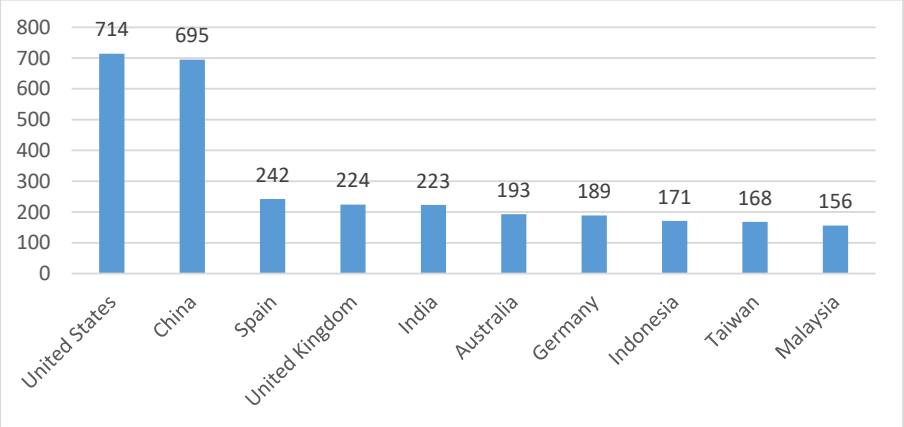

Figure 5. Analyze by Country

Three-Field Plot

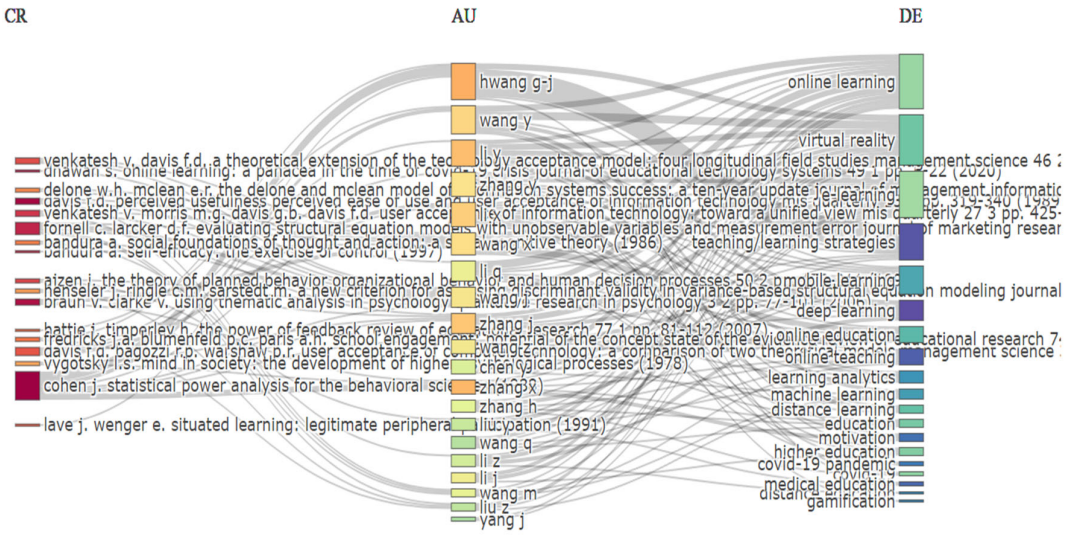

Figure 6. Three Field Plot

Figure 6 contains 3 observed elements; journal publication name, author name and theme/topic used. The three elements are then connected by a grey plot line related to each other. Based on the journal name, each journal shows which authors most often contribute to its publications, especially those that raise the theme of E-Learning.

The size of the plot shows how many publications are related to the theme. Based on the image above, there are 17 journals. The journal that publishes the most research on the theme of E-Learning is virtual reality which is shown in dark red and is connected to several authors such as Hwang GJ, Wang Y, Li Y, Yang J, and Li J.

Based on the image above, there are 10 sizes of the bar chart showing how many publications of research results from each author. Among the 10 authors, the ones who wrote the most articles on the theme of E-Learning are Liu Y, Li Z, Wang M, Liu Z, Yang J, Zhang J, Li Q, and Li Y.

The third element connects each research topic to authors who write about ICT literacy. From the analysis results, there are 17 keywords ICT literacy and Digital Literacy are in the top position. This shows that the word is very closely related to research related to ICT literacy.

Corresponding Author's Countries

Figure 7 shows the countries of the related authors. Based on SCP and MCP, there are 3 highest: China, USA, and Spain.

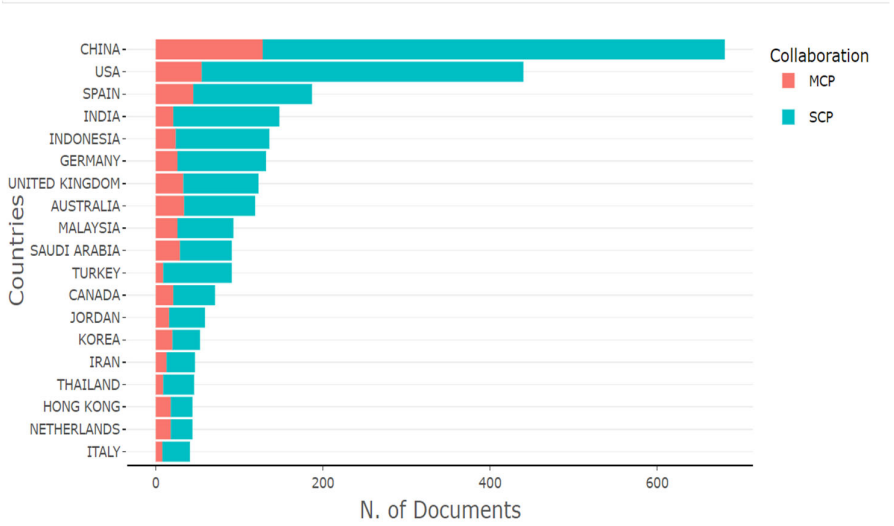

Figure 7. Corresponding Author's Countries

Most Globally Cited Document

The paper with the largest total citation (TC) is "ZRADIANTI J, 2020, COMPUT EDUC RASHEED RA, 2020, COMPUT EDUC" with 961 citations. Meanwhile, the paper with the largest TC per Year is "ZRADIANTI J, 2020, COMPUT EDUC RASHEED RA, 2020, COMPUT EDUC" with 240.25 citations per year. Based on these data, TC affects TC per Year. In general, in these data, papers with large TC also tend to have large TC per Year. Although not all papers with large TC must have large TC per Year. However, the paper's publication year tends not to have a significant effect on TC.

Table 2. Most Globally Cited Document

Paper	Total Citations	TC per Year	Normalized TC
RADIANTI J, 2020, COMPUT EDUC	961	240.25	41.98
RASHEED RA, 2020, COMPUT EDUC	481	120.25	21.01
IIVARI N, 2020, INT J INF MANAGE	459	114.75	20.05
KAPASIA N, 2020, CHILD YOUTH SERV REV	410	102.50	17.91
AL-BALAS M, 2020, BMC MED EDUC	328	82.00	14.33
ALQAHTANI AY, 2020, EDUC SCI	274	68.50	11.97
WANG AI, 2020, COMPUT EDUC	274	68.50	11.97
MAATUK AM, 2022, J COMPUT HIGH EDUC	238	119.00	41.26
TANG YM, 2021, COMPUT EDUC	221	73.67	15.54
MARTIN F, 2020, COMPUT EDUC	219	54.75	9.57

Most Local Cited Documents

The paper with the largest total local citations (LC) is “AL-EMRAN M, 2020, TECHNOL SOC” with 19 citations. Meanwhile, the paper with the largest total global citations (GC) is “MAATUK AM, 2022, J COMPUT HIGH EDUC” with 238 citations. Based on these data, LC does not affect GC.

Table 3. Most Locally Cited Documents

Document	Year	Local Citations	Global Citations	LC/GC Ratio (%)	Normalized Local Citations	Normalized Global Citations
AL-EMRAN M, 2020, TECHNOL SOC	2020	19	99	19.19	22.46	4.32
RAZA SA, 2021, J EDUC COMPUT RES	2021	16	198	8.08	27.87	13.92
ZHAO Y, 2021, COMPUT EDUC	2021	15	130	11.54	26.13	9.14
ZHAO Y, 2021, INT J ELECTR ENG EDUC	2021	15	4	375.00	26.13	0.28
ZHAO Y, 2021, INF PROCESS MANAGE	2021	15	88	17.05	26.13	6.19
ZHAO Y, 2020, COMPUT EDUC	2020	14	107	13.08	16.55	4.67
CHEN X, 2021, PROC ACM HUM COMPUT INTERACT	2021	13	22	59.09	22.64	1.55
ZHU X, 2020, TRANSP RES PART C EMERG TECHNOL	2020	13	5	260.00	15.37	0.22
MARTIN F, 2020, COMPUT EDUC	2020	12	219	5.48	14.19	9.57
MAATUK AM, 2022, J COMPUT HIGH EDUC	2022	11	238	4.62	42.05	41.26

Network Analysis

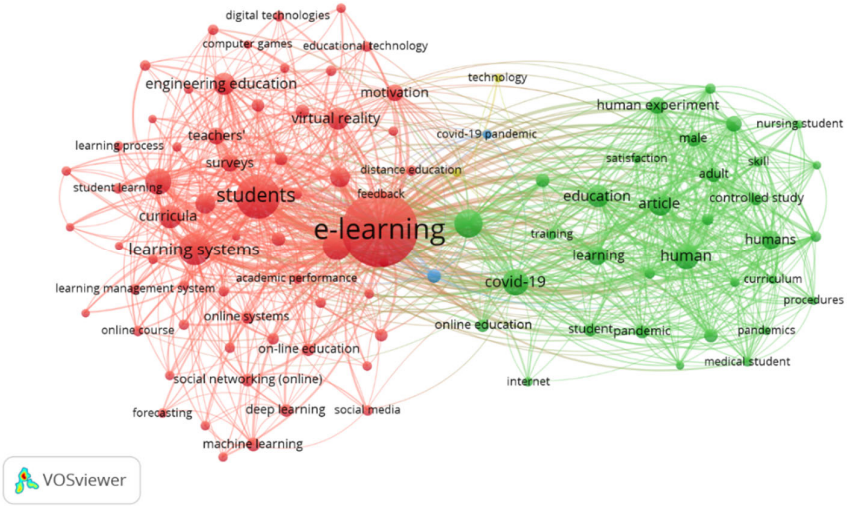

Figure 8. Network Analyze

In the figure, the number of occurrences of research on E-Learning is analyzed, with a minimum number of clusters of 2. 4 clusters are formed with the number of items in each cluster being: cluster 1 with 63 items, cluster 2 with 33 items, cluster 3 with 2 items and cluster 4 with 2 items. The dominant keyword is “E-Learning” with a total occurrence of 4503 and a link strength of 16757.

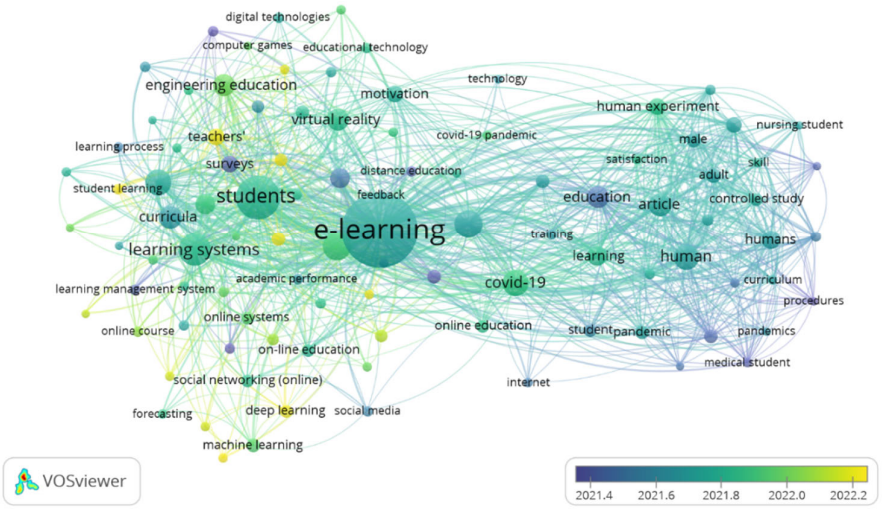

Figure 9. Overlay

The image above shows the analysis of keyword networks based on overlay. It can be seen that the keywords teacher, deep learning, machine learning are keywords with usage in the current year, namely 2022. While the keywords education, blended learning, surveys are keywords with relatively old usage around 2021.

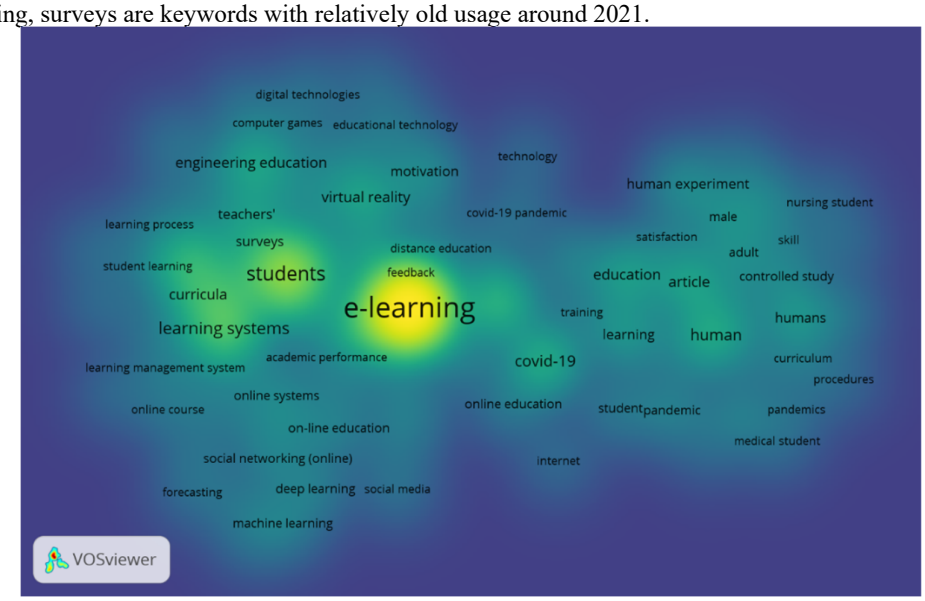

Figure 10. Density

Research density analysis reveals that the keywords “e-learning”, “student” has high density in this theme research. While keywords such as “internet”, “nursing student” and “waste management” are still rarely studied.

Table 4. Cluster

	Keywords	Occurrences	Cluster
1.	E-learning	4503	1
2.	Students	1529	
3.	Learning systems	849	
4.	Online learning	637	
5.	Curriculum	407	
1.	Teaching	634	2
2.	Covid-19	542	
3.	Human	486	
4.	Article	404	
5.	education	384	
1.	blended learning	149	3
2.	covid-19 pandemic	81	
1.	technology	59	4
2.	systematic review	67	

The table above shows the occurrence in each cluster that represents the main theme in E-learning research. The theme in the first cluster is Learner's Characteristics, the theme in the second cluster is Online Learning, the theme in the third cluster is Learning System. The theme in the fourth cluster is Learning Media.

Conclusion

Publications with the theme of E-Learning peaked in 2023. The most relevant author is Hwang, GJ with 25 publications. The affiliation with the most publications is with 35 publications. The country with the most publications is the US with 714 documents. The largest MCP is the US. ZRADIANTI J, 2020, COMPUT EDUC RASHEED RA, 2020, COMPUT EDUC is the document with the largest citations, namely 961 citations. The basic theme in research on E-Learning is learning, E-Learning is a dominant keyword with a link strength of 16757. The keyword education is a keyword with use in 2021. There are 4 mainstream themes, namely Learner's Characteristic, Online Learning, Learning System and Learning Media.

The limitations of this study only explore datasets indexed by Scopus and only analyze documents with English-language journal article types without considering other global indexing, languages, and document types other than articles.

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