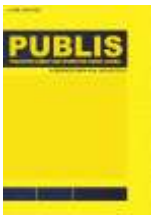

PUBLIS JOURNAL
Publication Library and Information Science
ISSN 2598-7852
Volume 8 Number 1 May 2024
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DIGITAL LIBRARIES IN EDUCATION: A BIBLIOMETRIC ANALYSIS ON THE WEB OF SCIENCE

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Keyword:
Digital Library
Education
Web Of Science

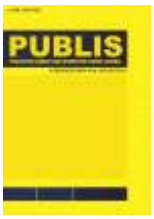
Article Info :
Submitted date
2024-01-11
Revised date
2024-06-21
Accepted date
2024-08-08

Abstract

This study aims to identify trends and developments in scientific publications related to digital libraries in education. The VOSViewer bibliometric analysis and visualization method was applied using the Web of Science (WOS) database from 2013 to early 2024. The study reveals significant developments in research over the past few years. It details research productivity and identifies the keywords 'higher education' and 'systematic review' as frequently associated with the main keywords. United states of america is identified as the most influential country in publications, with author Khan A and the journal Humanidades & Inovacao as the most contributors. The study's conclusion confirms that scientific publications on digital libraries in education are experiencing positive growth, in line with the development of information and communication technology (ICT).

Abstrak

Penelitian ini dilakukan dengan tujuan untuk mengidentifikasi tren dan perkembangan dalam publikasi ilmiah yang terkait dengan perpustakaan digital dalam konteks pendidikan. Metode analisis bibliometrik dan visualisasi VOSViewer diterapkan dalam kajian ini, menggunakan database Web of Science (WOS) dari tahun 2013 hingga awal 2024. Hasil penelitian menyoroti perkembangan yang signifikan dalam penelitian selama beberapa tahun terakhir. Penelitian ini merinci produktivitas penelitian serta mengidentifikasi kata kunci *higher education* dan *systematic review* sebagai kata kunci yang sering dikaitkan dengan kata kunci utama. Amerika Serikat diidentifikasi sebagai negara yang paling berpengaruh dalam publikasi dengan penulis Khan A dan jurnal Humanidades & Inovacao sebagai kontributor utama. Kesimpulan dari penelitian ini menegaskan bahwa tren publikasi ilmiah tentang perpustakaan digital dalam pendidikan mengalami pertumbuhan yang positif seiring dengan perkembangan teknologi informasi dan kemunikasi (TIK).



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INTRODUCTION

The rapid development of information and communications technology (ICT) has brought various impacts on various fields of global life, including the library sector. (Subrata, 2009). One of the impacts of the technological revolution is the emergence of digital libraries (Saleh, 2014). The paradigm shift in information management and access to digital marks the evolution of libraries towards a more modern and efficient form in response to the rapid development of Information and Telecommunications Technology (ICT). An innovative approach to digital libraries includes the utilization of technology to present collections of information dynamically and interactively to users (Sugiyanti, 2023).

A digital library is a library that uses technological aspects to manage information collections in digital form (Widayanti, 2015). Furthermore, Arum & Marfianti (2021) explain that digital libraries are electronic collection resources (e-resources) and related technologies that enable the creation, creation, search, and use of information in various media, including text, images, and sound.

Digital libraries have significant advantages in providing access to information without space and time constraints, enabling efficient use of information, as well as increasing collaboration in the exchange of resources between libraries globally, and allowing users to get information quickly, accurately, and without having to be physically present in the library (Prabowo, 2013). Based on Susanto's (2019) research study, the main advantages of digital libraries include ease of access, more affordable costs, and the availability of more complete collections.

Digital libraries, as an evolutionary form of traditional libraries, have several advantages that can have a positive impact on the field of education. Mubarok (2021) in his research highlights the crucial role of digital libraries in supporting distance learning. The main advantage lies in access without time and place

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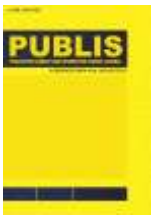
restrictions, allowing students to access various reference sources in various forms, and contributing to improving the quality of learning with more flexible services. Another study conducted by Mahardhani et al. (2021) revealed that the implementation of a digital library using SLiMS 9 Bulian provides significant benefits for libraries and users, which helps improve student literacy and provides a better user experience in searching and obtaining information. Furthermore, a study conducted by Winastwan (2021) added that digital libraries are not only a replacement for conventional library services, but also an alternative that manages digital format collections. This allows easy access to information, speeds up the information search process, and also helps preserve library information content, especially in pandemic situations where physical activity is limited.

The existence of digital libraries will have an impact on the role of libraries as information and learning centers, which play a significant strategic role in determining the quality of educational outcomes (Hakim, 2005). This view is in line with the function of libraries as stipulated in Law No. 43/2007 on Libraries, libraries function as a vehicle for education, research, preservation, information, and recreation. In addition, libraries also function to improve the intelligence and empowerment of the nation. So in the context of the role of digital libraries, having involvement in the learning process is positively correlated with efforts to empower and increase knowledge for educators and students in the world of education (Batubara, 2013). Furthermore, Eskha (2018) explains that the role of libraries is very important in the context of education as a place that is the main source of learning and supports teaching and learning activities. Without the support of a library, an educational institution, be it a school, university, or company, may not be able to be organized properly.

The presence of digital libraries can provide various advantages that are very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important in supporting the learning, research, and teaching processes in the digital era. Digital libraries make it easier for the community and academic community to access and utilize various educational resources, including electronic books, journals, and interactive learning materials (Hutasoit, 2012).

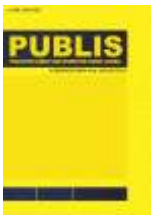
In the related literature, there have been many studies that carry the topic of digital libraries in the educational aspect. For example, research by Anjani and Winoto (2022) presents an analysis of scientific publications on digital libraries, with the method used Harzing's Publish or Perish analysis tool, as well as data visualization through the VOSviewer application. The research publication data was obtained from Google Scholar with a range of years 2011-2021. Another research conducted by Widiyanto (2023) also conducted a research study focusing on analyzing digital libraries in the context of higher education. The approach uses bibliometrics by utilizing the Scopus database, and the research period covers 2009 to 2023. Nonetheless, it should be noted that while there have been several previous studies, there is still a lack in the number of studies that specifically address the trends and developments of digital libraries in education.

Thus, the purpose of this research is to fill the gap by providing a more specific focus on the trends and developments of digital libraries in education. The bibliometric analysis method was applied to the Web of Science (WOS) database from 2013 to early January 2024. In this study, the research questions were formulated as follows:

RQ1. — How has research on digital libraries in education developed between 2013 and early January 2024?

RQ2. — What are the research focuses and topics regarding the development of digital libraries in education?

To answer the above questions, the authors used bibliometric analysis to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identify the relationship between related keywords, the number of publications per year, the most relevant authors, and author collaboration cooperation with the most relevant publication journals. This bibliometric analysis methodology was chosen because it is useful for obtaining a comprehensive understanding of the development of scientific literature, besides that it can also be used to evaluate the impact and dissemination of knowledge in a scientific literature study (Aria and Cuccurullo, 2017).

These questions will guide the research, guide the data analysis, and provide answers that explain the phenomenon under study. Therefore, this research is expected to contribute to the development of understanding of digital libraries and play a significant role in the field of Information and Library Science. It is hoped that this research will not only provide new insights but also deepen the understanding of digital libraries in the context of education, making it an important reference for future studies that want to explore specific aspects related to digital libraries.

This article is presented in several sections. The first section provides an introduction to the literature on the background of the digital library phenomenon in education. The second section details the research methodology, including the data collection and analysis techniques applied. The third section presents the results of the bibliometric analysis conducted. The fourth section discusses the implications of the findings. In the fifth section, the study concludes with a comprehensive summary of its findings.

METHODS

This research uses a bibliometric analysis approach and VOSViewer visualization related to digital libraries in education. Bibliometrics is a science that studies the use of statistical methods to measure qualitatively or quantitatively the development of publications, information, and others related

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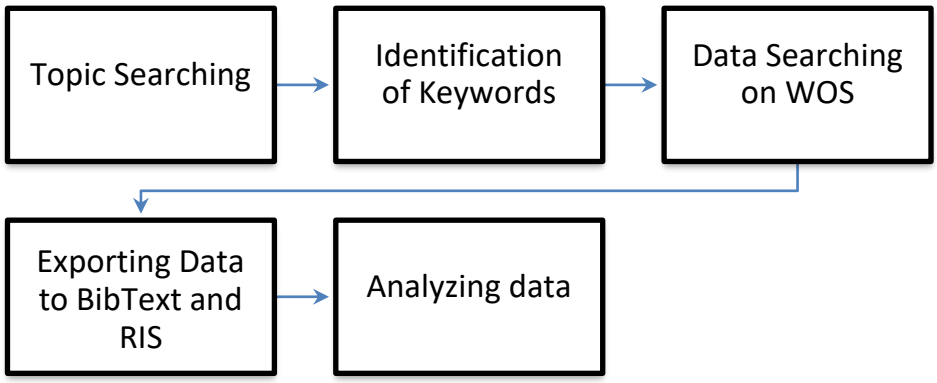
to certain fields of scientific research (Hakim, 2020). In this study, researchers used bibliometric analysis to provide an overview of the characteristics of scientific literature. Bibliometric analysis is used to find recent developments in articles and journals (Donthu et al., 2021).

The scientific literature search process was conducted using the keywords "Digital Library" and "Education." Researchers utilized the search feature by selecting the search field, Topic, which includes title, abstract, author keywords, and Keyword Plus. The publication year range was limited to 2013 to early 2024. A total of 492 publications were found through the Web of Science (WOS) database according to the keywords used. The collected publication data was then processed and analyzed using Biblioshiny and VOSViewer.

Figure 1. Flowchart of research method steps



In Flowchart 1, five main stages are carried out in this research. First, determining the research topic, which in this case is related to digital libraries in education. Second, determining the research keywords that form the basis of the search, namely "Digital Library" and "Education". Third, proceed with searching data on the Web Of Science (WOS) based on these keywords. This process involves setting search boundaries, with the search field being topics that include titles, abstracts, keywords, and keywords plus, and limiting the range from 2013 to early January 2024. Fourth, after the data was collected, the data was

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exported into BibTex and RIS formats to be analyzed using biblioshiny and VOSViewer. Finally, in the fifth stage, data analysis was carried out by the research objectives.

RESULTS

The results of the bibliometric analysis show that the use of digital libraries in education has increased significantly from 2013 to early January 2024. This analysis not only reveals the patterns and developments of previously conducted research, but also evaluates several important dimensions in the trends of related scientific literature. These dimensions include publication trends, research focus and topics, identification of key contributors, exploration of frequently occurring keywords, and analysis of collaborative networks among researchers. The following are the results of the analysis:

Development by Year

Table 1. Development of research related to digital libraries in education by year

No	Year	Article
1	2013	30
2	2014	34
3	2015	44
4	2016	34
5	2017	36
6	2018	38
7	2019	39
8	2020	54
9	2021	60
10	2022	61
11	2023	60
12	2024	2

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	Total	492

Table 1 Shows the development of scientific article production by year. As can be seen from the data in the table, there is a dynamic growth trend over the period 2013 to 2024. There was a significant increase in the number of articles published from 30 in 2013 a peak of 60 at the end of 2023 and a decline to 2 publications at the beginning of 2024, with an accumulative total of 492. Peak growth was seen in 2022 with 61 articles. Despite annual fluctuations, the average growth shows a positive trend, reflecting increased research activity or contributions from the scientific community.

Most quoted country

Table 2. Most cited country data

Country	TC	Average Article Citations
USA	699	12.90
UNITED KINGDOM	239	14.90
AUSTRALIA	238	21.60
JAPAN	232	38.70
CHINA	222	7.40
CANADA	174	19.30
PAKISTAN	149	6.20
NETHERLANDS	111	27.80
SPAIN	105	17.50
MALAYSIA	89	9.90
BRAZIL	79	0.60
SWITZERLAND	73	36.50
SAUDI ARABIA	66	6.60
TURKEY	58	6.40

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INDIA	46	2.40
FINLAND	40	10.00
IRAN	31	15.50
COLOMBIA	30	6.00
SOUTH AFRICA	30	3.80
BELGIUM	27	27.00
GERMANY	26	5.20
ZIMBABWE	24	24.00
ITALY	21	2.30
KUWAIT	21	21.00
RUSSIA	21	1.90

Table 2 presents data on the average number of citations per country on the research topic "digital libraries in education". The data in Table 2 provides the total citations of each country, the United States (USA) ranked first with the highest number of citations, namely 699 or 12.90% of the total citations. Meanwhile, the United Kingdom and Australia ranked second and third respectively with 239 (14.90%) and 238 (21.60) citations. Japan, China, and Canada also achieved a high number of citations, with 232 (38.70%), 222 (7.40%), and 174 (19.30%) citations respectively. In contrast, the three countries with low citation frequency are Italy, Kuwait, and Russia with 21 (2.30%), 21 (21.00%), and 21 (1.90%) citations respectively. shows those countries with the lowest number of citation frequency in the topic

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Most Relevant Sources

Figure 2. Most Relevant Sources

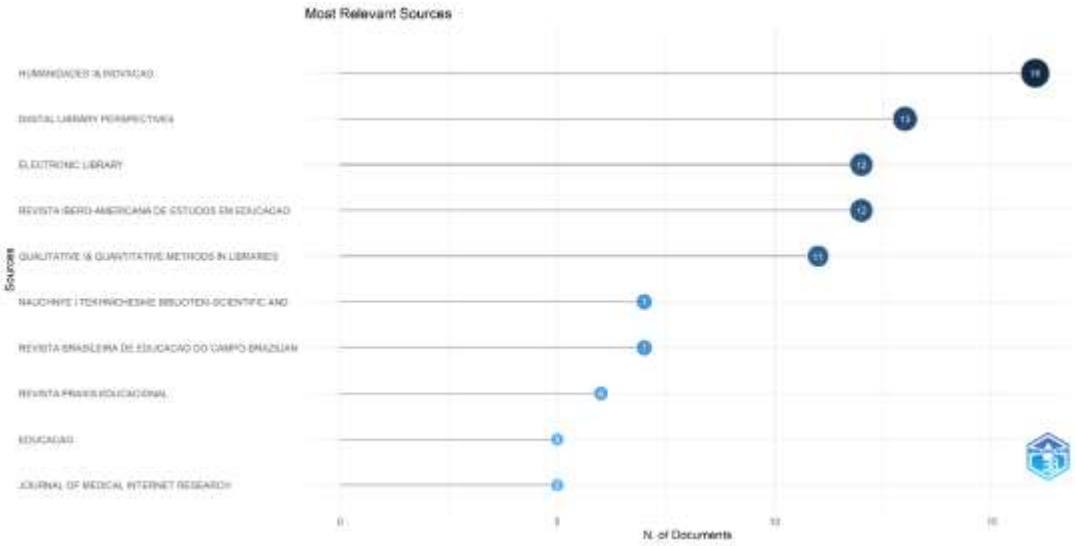

Figure 2 shows the 10 most relevant sources of publications on digital libraries in education. The Journal of Humanidades & Inovacao stands out as the first with a total of 16 publications, followed in second and third place by the Journal of Digital Library Perspectives with a total of 13 publications, and the Journal of Electronic Library with a total of 12 publications. Furthermore, the fourth and fifth rankings are the Revista Ibero-americana de Estudos em Educacao and Qualitative & Quantitative Methods in Libraries journals, which published 12 and 11 publications respectively. Then in the sixth and seventh rank are the journals Nauchnye I Tekhnicheskie Biblioteki-Scientific And Technical Libraries and Revista Brasileira De Educacao Do Campo-Brazilian Journal Of Rural Education with the same total number of publications, namely 7 publications. Furthermore, there is the journal Revista Praxis Educacional with a total annual publication of 6 publications. Finally, in ninth and tenth place, Educacao and the Journal of Medical Internet Research have 5 publications each.

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Most Relevant Authors

Figure 3. Most Relevant Authors

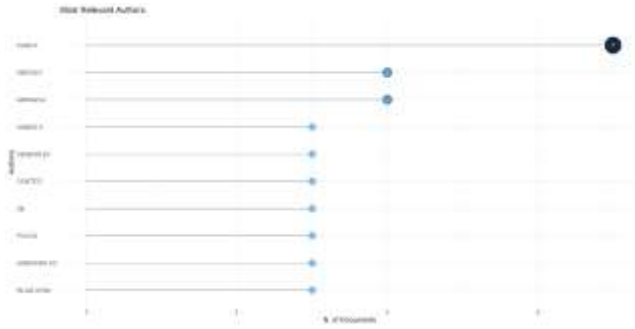

Figure 3 shows the author relevance analysis of publications on digital libraries in education, the ten most relevant authors can be identified based on the number of publications they produced. The most dominant researcher in terms of publication contribution is Khan A., who created seven publications related to the topic. This is followed by Ameen K and Arshad A with four publications each. Meanwhile, the other authors are Ahmad K, Cendon Conte E, DE, Fox EA, Habowski AC, and Islam Ayma, each with three publications.

Author Collaboration Pattern

Figure 4. Author cooperation pattern

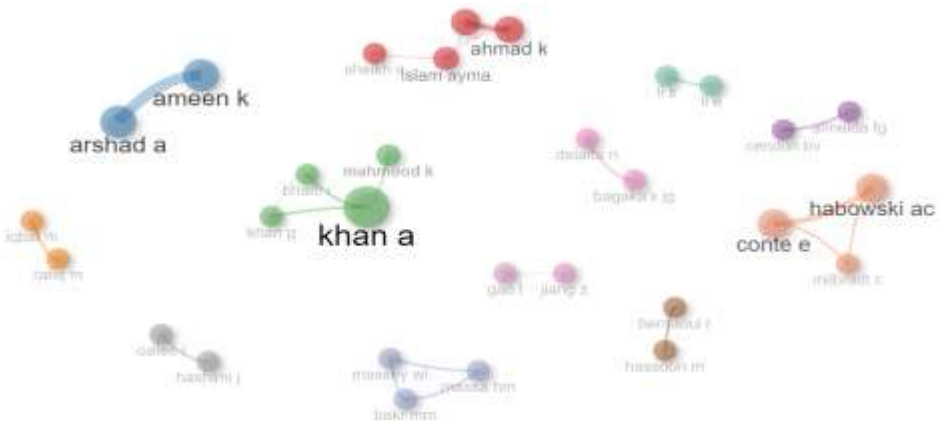

Figure 4 shows eleven patterns of cooperation between authors related to digital library research in education. These cooperation patterns can be observed

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through the color and size clusters in the figure. Author Khan, who belongs to the green cluster, seems to have a dominant role in this research context. With a large cluster size, Khan A. collaborates with authors Mahmood K, Bhatti R., and Khan G., showing significant contributions to the research development. Furthermore, the author with the orange cluster, Habowski AC, is seen collaborating with authors Conte E and Milbradt C, forming a significant research group. Authors Arshad A and Ameen K, although only collaborating, display strong cooperation with large cluster size and significant research impact. Furthermore, author Ahmad K formed a network of collaboration clusters with Rafi M, Islam Ayma, and Sheikh A that formed a red collaboration that was quite significant in the development of this research. Finally, the collaboration of other authors, although not as large as the other clusters, has a considerable and meaningful contribution impact.

Research Topic Trend Analysis

Table 3. Topic Trend Data

Item	Freq	Year_q1	Year_med	Year_q3
university library	10	2015	2015	2017
information	7	2014	2015	2017
information literacy	7	2014	2015	2016
digital libraries	27	2014	2016	2020
theses	5	2016	2016	2016
digital library	63	2015	2017	2021
universities	7	2016	2017	2018
library	12	2016	2018	2020
Pakistan	12	2017	2018	2021
digital	10	2017	2018	2021

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learning	12	2017	2019	2021
training	8	2016	2019	2022
special education	6	2018	2019	2021
education	52	2016	2020	2022
higher education	19	2018	2020	2022
academic libraries	9	2016	2020	2021
systematic review	15	2018	2021	2022
meta-analysis	9	2018	2021	2022
state of knowledge	9	2020	2021	2022
review	11	2018	2022	2022
covid-19	8	2021	2022	2022
children	7	2022	2022	2022

Table 3 show the topic trend data using the author keywords field shows variations in the focus of digital library research in education over the past few years. One topic that stands out is "Digital Library," which reached a high frequency of 63 times and took center stage from 2015 to 2021. This reflects the dominant role of digital library keywords in the scientific literature data used. In addition, the topic "Education" was also highlighted with a frequency of 52. Attention to "Higher Education" is also evident, with significant growth from 2018 to 2022, reflecting a specific research focus on the higher education context. "Systematic Review" showed growth from 2018 to 2022, signaling a trend towards using systematic review methods in research. Furthermore, the impact of the pandemic is visible through the increased frequency of the topic "COVID-19" in 2021 and 2022. In addition, the topic "Children" emerged as a new trend in 2022, reflecting a possible increased interest in the educational aspects of children.

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Cluster by Author Coupling

Figure 5. Clusters based on Author Coupling

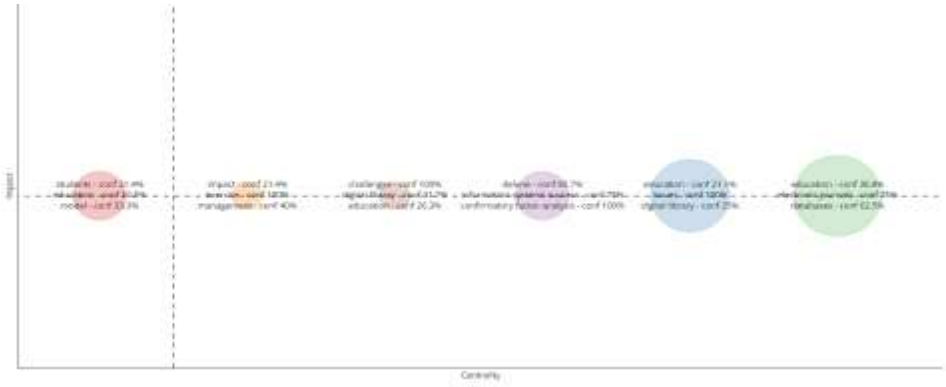

Figure 5 illustrates clusters based on author coupling related to the research topic of digital libraries in education. This data was generated using clusters based on author coupling. There are six clusters: pink, orange, brown, purple, blue, and green. The first cluster, colored pink, includes the keywords "students", "education", and "model" with percentage proportions of 21.4%, 10.5%, and 33.3%, respectively. The second cluster consists of the keywords "impact", "exercise", and "management" with percentage proportions of 21.4%, 100%, and 40%, respectively. The third cluster, colored brown, includes the keywords "challenges", "digital library", and "education" with percentages of 100%, 41.7%, and 26.3%, respectively. The fourth cluster, colored purple, includes the keywords "delone", "information systems success", and "confirmatory factor analysis" with percentages of 85.7%, 75%, and 100%, respectively. The fifth cluster, colored blue, includes the keywords "education", "issues", and "digital library" with percentages of 21.1%, 100%, and 25% respectively. Finally, the sixth cluster, colored green, includes the keywords "education", "electronic journals", and "databases" with a percentage proportion of 36.8%, 75%, and 62.5%.

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Figure 6. Network Visualization Co-occurrence

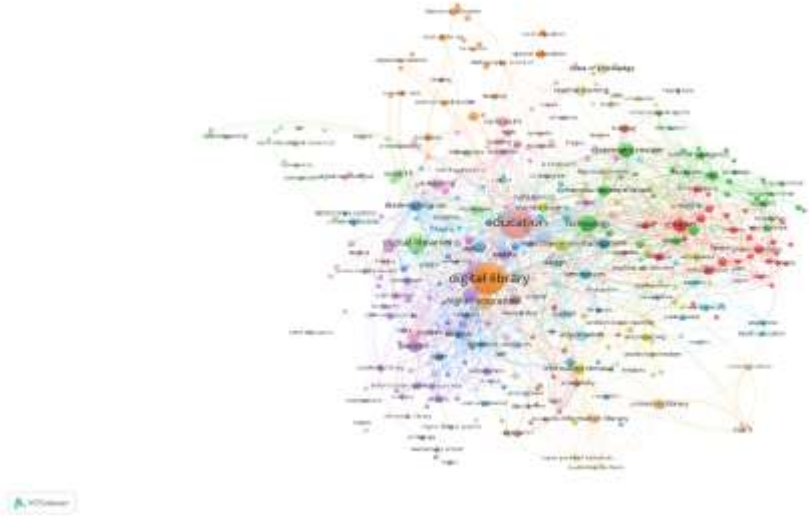

Figure 6 illustrates the visualization based on Network Visualization on Co-occurrence analysis using VOSViewer software related to research publications in digital libraries in the context of education. The analyzed data shows 2161 keywords with 393 thresholds detected. In the cluster representation, the most dominant keywords are marked with a larger sphere size, reflecting their level of dominance. The larger the sphere size, the more dominant the keyword is. Meanwhile, in the context of proximity between cluster spheres, this reflects the high chance of co-citation of the keyword. The largest cluster in the figure, "Digital Library" in yellow, shows 76 occurrences, divided into 7 clusters, with a total of 163 links and a total strength of 266 in those links. The purple "Education" cluster shows 75 occurrences, divided into 9 clusters, with a total of 180 links and a total strength of 298 on those links, in addition to these keywords. Other keywords such as "Students", "technology", "children", "digital libraries", "university", "systematic review", "university library", "impact", "quality", "pressure" and "information" also appear as significant keywords.

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Figure 7. Overlay Visualization Co-occurrence

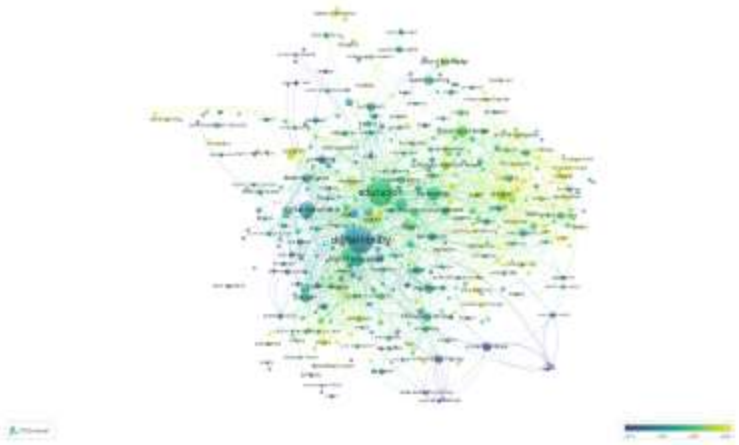

Figure 7 visualizes the results of the Co-occurrence analysis using the Overlay Visualization technique in VOSViewer software focusing on research publications in the context of education in digital libraries during the period 2013-2024. In this representation, the color of the circles reflects an indicator of the length of existence of the research keywords, where darker color intensity indicates that the word has been the subject of research for a longer time, while lighter intensity signifies that the word is still considered a relatively new subject. This analysis highlights several keywords that have significance from 2013 to early January 2024. In particular, the circles that are the largest and have a high and dark color intensity are "digital library" and "digital libraries" indicating that this topic has been the focus of research for the longest period and still maintains its relevance. On the other hand, the keywords "education", "children" "systematic review" and "technology" have a fairly light color despite their size, indicating that in the context of the length of time of research publications, these concepts are still considered to be relatively new subjects than "digital library". Furthermore, the keyword "hybrid teaching conception of teaching" has a very

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light color and is the furthest away. This indicates that this term emerged as a very new subject in educational research in the period analyzed.

Co-Occurrence Analysis Using Vosviewer Based on Density Visualization

Figure 8. Density Visualization Co-occurrence

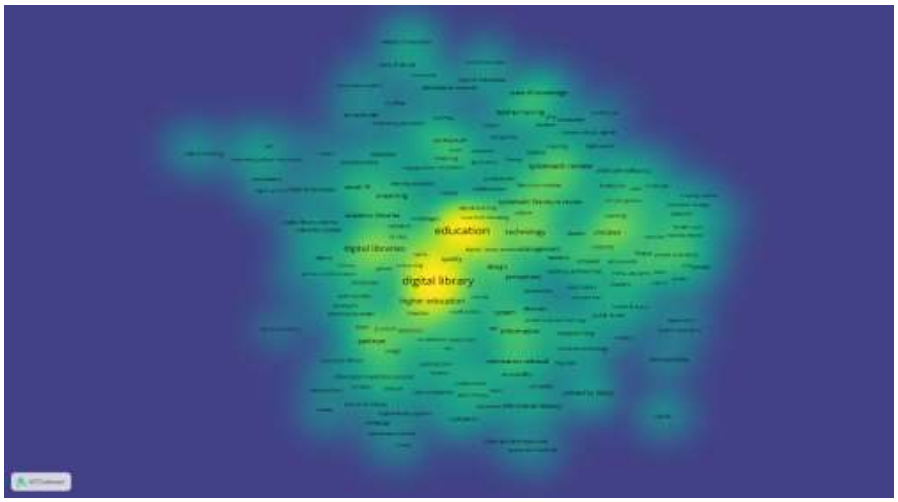
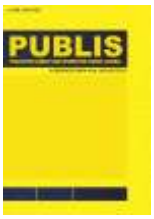


Figure 8 illustrates the results of the Co-occurrence analysis using the Density Visualization technique in the VOSViewer software. This visualization reflects the keywords that are the focus of the research, with color indicators reflecting the level of significance of the topic. The lighter the color of a keyword, the more intense the research or discussion on the topic, while darker colors indicate a lower level of research or discussion.

In this visualization, keywords such as digital library, education, higher education, digital libraries, Pakistan, technology, and children show a lighter color, indicating that topics related to these keywords have been the focus of significant research. In contrast, keywords such as health care, stem education and communication show a darker color, indicating that these topics are under-researched or under-discussed in the literature.

DISCUSSION

This study analyzes trends and developments in digital library research publications in education using data from the Web of Science (WOS) database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from 2013 to early January 2024. A total of 492 data points were analyzed.

The study's results revealed several main findings. Firstly, Khan A was identified as the primary author in this field, having published a total of 7 related articles. Analysis of author collaboration patterns also showed significant collaboration between Khan A and Mahmood K, Bhatti R, and Khan G. Secondly, several journals published the most articles on digital libraries in education. Humanidades & Inovacao, Digital Library Perspectives, and Electronic Library have published 16, 13, and 12 articles on the topic, respectively. The United States had the highest average citation count, with 699 or 12.90% of the total citations received, indicating the significant influence and contribution of research in digital libraries in education from the United States.

Fourth, this study emphasizes the most relevant and frequently occurring keywords, including 'Higher Education' and 'Systematic Review.' The visualization using VOSViewer also revealed the significance of other keywords such as 'digital libraries,' 'university,' and 'technology,' reflecting the focus on technological aspects in the context of digital libraries in higher education. Additionally, the terms 'Covid-19' and 'children' were present, indicating a recent research focus on the effects of the pandemic and the use of digital libraries in children's education. Meanwhile, other keywords are still less explored and have the potential for further development related to digital libraries in education, such as "health care", "STEM education", and "communication". Research development on these aspects can further contribute to a deeper understanding of digital libraries in educational contexts.

In a similar study conducted by Widiyanto, who examined the development of digital libraries in higher education in Scopus by using the keywords "digital library" and "higher education" and applying bibliometric method analysis, the findings showed that the keyword "Education" often appeared as the most related keyword to the main keyword. This finding

confirms the significant relevance of the obtained research results, indicating that the focus on educational aspects has a great impact on the digital library and higher education literature.

CONCLUSIONS

The research on digital libraries in education has shown dynamic growth and evolving trends over the years 2013 to early 2024. The number of publications has increased steadily, with notable peaks in certain years. The number of publications experienced a significant increase from 30 articles in 2013, reaching its peak with 61 articles in 2022. Despite a decline to 2 publications at the beginning of 2024, the overall trend shows a positive growth trajectory in research activity.

The research focuses and topics regarding digital libraries in education are diverse and have evolved over the years. The research areas identified, such as "Digital Library," "Education," "Higher Education," "Systematic Review," provide insight into the dominant trends in these areas. However, the increased research interest in "COVID-19" and specific educational contexts like "Children" suggests a response to current issues and the potential for developing new topics in the digital library literature.

Based on these findings, future research could expand the understanding of specific aspects and explore the practical implications of the results to enhance the utilization of digital libraries in education more effectively. This study provides a comprehensive insight into recent research developments on digital libraries in educational contexts and offers suggestions for future research directions.

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