Pedagogia Jurnal Ilmu Pendidikan

A Bibliometric Analysis on Research Trends of Digital Leadership in Education

Moses Adeleke Adeoye, Olaolu Paul Akinnubi, Gema Rullyana

Educational Management & Counselling, Faculty of Education, Al-Hikmah University Ilorin, Nigeria

*Correspondence: E-mail: princeadelekm@gmail.com

ABSTRACT

This study aims to comprehensively review research on 'digital leadership in education' by conducting bibliometric analysis of 60 publications from journal articles and proceedings between 2015 and 2023 using the Scopus database. Data analysis in this study consists of performance analysis and science mapping. Data analyses of co-authorship, bibliographic merging, keyword occurrence, and citations were performed on bibliometric meta-data using VOSViewer software. The study highlighted the number of publications, fields of study, affiliations, universities, countries, and the most productive and influential researchers. In addition, the study also identified research topics that researchers have been working on in recent years. The findings show that publications and citations have increased in the last five years. Malaysia, Indonesia, the United Kingdom, Greece, and the United States are this topic's most productive countries. Hera Antonopoulou (University of Patras, Greece) is the most productive researcher, while Turgut Karaköse (Firat University, Turkey) is the most influential author. The affiliation that contributed the most was the State University of Malang (Indonesia). The results of data analysis show that collaboration between authors who research this topic is still nil. This is an opportunity to open up opportunities for collaboration between authors.

1. INTRODUCTION

Based on the latest empirical data from the special Eurobarometer survey conducted in September 2021, digital technologies have proven beneficial to the economy because they offer privileges in people's lives. In addition, digital technologies, in recent years, have transformed information, values, and management and driven organizations, not only in business but also in education (Cortellazzo et al., 2019). Digital Transformation is an ongoing process that increases the level of digitalization within an organization. (Ivančić et al., 2019). By using more digital technology, business processes are transformed so that many digital business models are created (Klein, 2020). Meanwhile, digital leadership is the integration of digital technologies such as mobile devices, communication applications, and web applications in leadership practices (Temelkova, 2020; Yusof et al., 2019). Furthermore, digital leadership in education refers to the integration of technologies, tools, and instruments such as the Internet of Things (IoT), social media, artificial intelligence, big data, and machine learning (Antonopoulou et al., 2021).

One of the most recent studies on digital leadership was conducted by AlAjmi. The study explored the impact of digital leadership among principals on teachers' technology integration during the COVID-19 pandemic in Kuwait. This quantitative research utilized the Principal Technology Leadership Survey and the Teacher Technology Integration Survey. The sample consisted of 113 principals and 404 teachers of public primary schools in Kuwait. The results revealed that digital leadership among principals had a positive impact on teachers' technology integration during the COVID-19 pandemic. (AlAjmi, 2022).

Further research was conducted by Karakose on the topic of Development and Evolution of Digital Leadership with a bibliometric approach. The results revealed that the scope of digital leadership research is gradually developing and diversifying, and the publication results continue to increase. These findings enable a better understanding of digital leadership and the provision of reference services for future research by uncovering the conceptual structure and thematic evolution of the digital leadership knowledge base (Karakose, et al., 2021).

Sunarsi, in 2020, also examined the impact of e-leadership in organizations. The study aims to analyze the effect of e-leadership, organizational commitment, and service quality on school performance involving 200 teachers in Banten (Indonesia) schools. The results of data analysis show that e-leadership, organizational commitment, and service quality significantly affect school performance. The novelty of this study is the first leadership research model with e-leadership, organizational commitment, and service quality variables on school performance (Sunarsi et al., 2020).

Another related research is the research conducted by Harto in 2020. This research provides an extensive bibliographic literature review based on concepts and terms about digital leadership to improve innovation in organizations. This research resulted in 96 publications that were eligible for study, ranging from 1994 to 2021. The papers were also reviewed through VOSviewer software. The results revealed that strategic digital leadership could increase innovation in organizations. The density and network visualization shown by the VOSviewer software shows that innovation is indeed a keyword in most digital leadership-themed papers, and strategic digital leadership can drive innovation in an organization (Harto et al., 2022).

Another study by Aggarwal used a bibliometric approach to explore the concept of e-leadership and determine the different dimensions of leadership in a virtual environment. The study's results provide possible future research directions by identifying the relationship of

several variables, such as digital leadership, use of information and communication technology, and effective communication channels (Aggarwal 2022).

As far as we can see, relatively few studies on digital leadership in education have analyzed the performance of science and mapping in recent years. Based on this, this research examines studies on digital leadership in education for the period 2015-2023 using the Scopus database. Then, previous bibliometric research mostly focuses on digital leadership in a general field. This is the gap in this study, so the researcher aims to analyze research trends on digital leadership in education through bibliometric analysis. This analysis includes performance analysis and science mapping. This research contributes by offering a snapshot of the field's growth over the last few years (2015-2023). It provides a comprehensive reference source for researchers researching digital leadership in education.

2. METHODOLOGY

This research uses a descriptive method with a bibliometric approach. In its application, the bibliometric approach uses quantitative techniques (Donthu et al, 2021; Mukherjee et al., 2022; Todeschini & Baccini, 2016). This research uses the Scopus database as its data source; as one of the scientific databases, Scopus is a highly reputable source of scientific data. (Baas et al., 2020; Kulkanjanapiban & Silwattananusarn, 2022; Pranckutė, 2021). The analysis of this study focuses on two parts: (1) bibliometric mapping to assess trends in Microcredentials in Higher Education, and (2) analysis of keywords indexed in articles to identify research clusters and understand research themes related to Microcredentials in Higher Education. Data analysis was aided by network visualization, overlay visualization, and density visualization displayed by VOSviewer software for easier reading (Hsieh & Hsu, 2022; Van Eck & Waltman, 2010). The software can provide information on network metrics and clustering (Van Eck & Waltman, 2010; McAllister, Lennertz, & Mojica, 2022). There are 5 steps of bibliometric analysis used in this study, as presented in Figure 1.

| Defining Search Kerword | → | Initial Search Results | → | Refinement of the Seacrh Results | → | Compiling the Initial Data Statistics | → | Data Analysis |

Figure 1. Bibliometric Steps Analysis

2.1 Defining Search Keywords

The keyword searches selected for use in the literature search in the Scopus Database conducted on Feb 05, 2023 were 'digital leadership' OR 'e-leadership' AND 'education' OR 'school.' As a first step, the researcher selected the document features in the Scopus database; then, the keywords were written in the document features subsection, namely 'document search' with the search format options 'article title,' 'abstract,' and 'keywords.'.

2.2 Initial Search Results

The initial search yielded 78 matching documents for 'digital leadership in education' sourced from Articles, Conference Papers, Book Chapters, Conference Reviews, Reviews, Books, Editorials, Erratums, and all languages. These documents were also excluded without the use of a time range setting.

2.3 Refining the Search Results

Some specific criteria were set to obtain suitable documents for this study. Firstly, the document's title contained the keywords 'digital leadership' AND 'education' OR 'school.' Secondly, the documents were written in English. Thirdly, the documents were from journal sources and proceedings. Fourth, the documents were published in the period 2015-2023. Systematically, the selection of documents that fit the inclusion criteria was carried out through 4 steps: 1) identification, 2) screening, 3) eligibility, and 4) inclusion. 'digital leadership' AND 'education' OR 'school.' The inclusion process resulted in 60 publications on 'digital leadership in education' sourced from the document types of journal articles and proceedings in English, published in 2015-2023.

2.4 Compiling the Initial Data Statistics

Eligible documents were then used as research data sources. Data was obtained (downloaded) from the Scopus database in 2 types of formats, namely Comma Separated Values (CSV) and Research Information System (RIS). Both forms contain important article information, such as bibliometric and bibliographic information (Kumar et al., 2020; Ma & Yang, 2014).

2.5 Analyzing the Data

Data analysis in this study consisted of performance analysis and science mapping. Data analyses of co-authorship, bibliographic coupling, keyword occurrence, and citations were performed on bibliometric meta-data using VOSViewer software. For bibliographic coupling, relationships of elements such as publications, journals, and authors were determined based on the number of shared resources. Keyword occurrence analysis reveals trends in a field of study over time. Therefore, bibliometric approaches are efficient for identifying trends in a particular research field (Donthu et al, 2021; Mukherjee et al., 2022; Todeschini & Baccini, 2016). Citation analysis helps researchers detect popular research topics being worked on by other researchers (Donthu et al, 2021; Mukherjee et al., 2022). The analysis results are then presented as a table or network visualization map.

3. Results & Discussion

Based on data obtained from a search using the Scopus database, 60 articles with the search keywords 'digital leadership' OR 'e-leadership' AND 'education' OR 'school' were found published in journals and proceedings in the 2015-2023 timeframe. Figure 1 shows the development of publications from 2015 to 2023.
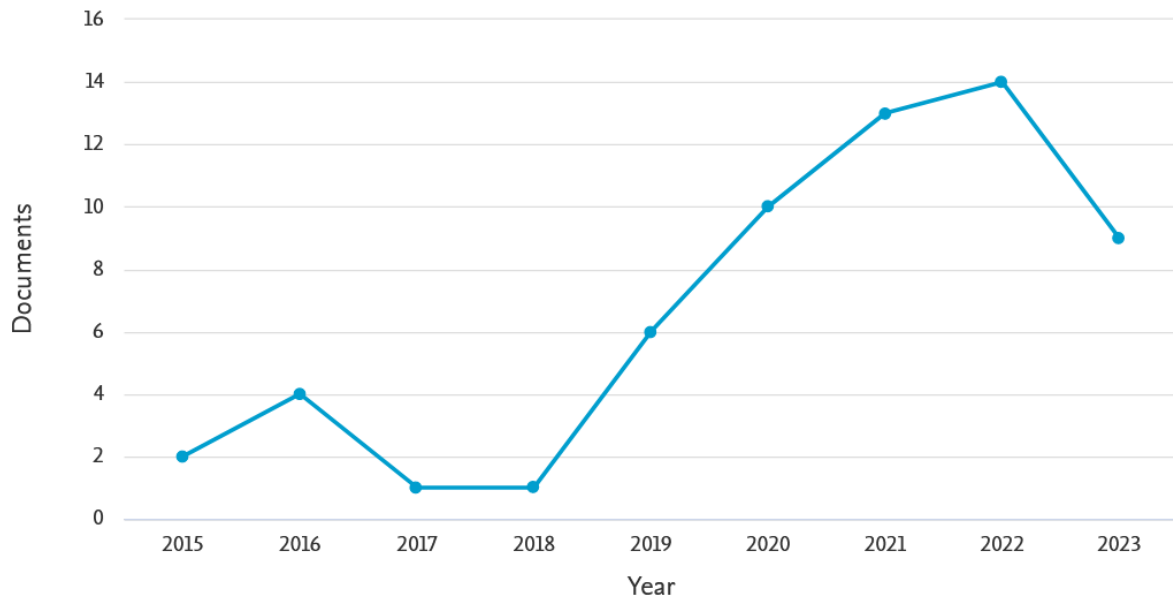
Figure 3. The Development of Research Publications on Digital Leadership in Education

Based on bibliometric analysis, publications on 'digital leadership in education' cover 29 countries. Researchers obtained data on 10 countries with the highest number of documents, namely Malaysia, in the first place with 11 publications. The second and third places are Indonesia and the United Kingdom with 7 publications each, fourth and fifth, Greece and the United States with 4 publications each. Furthermore, in the sixth, seventh, and eighth positions are Israel, Thailand, and Turkey, each publishing 3 publications. Australia and China occupy the ninth and tenth places, each publishing 2 publications.
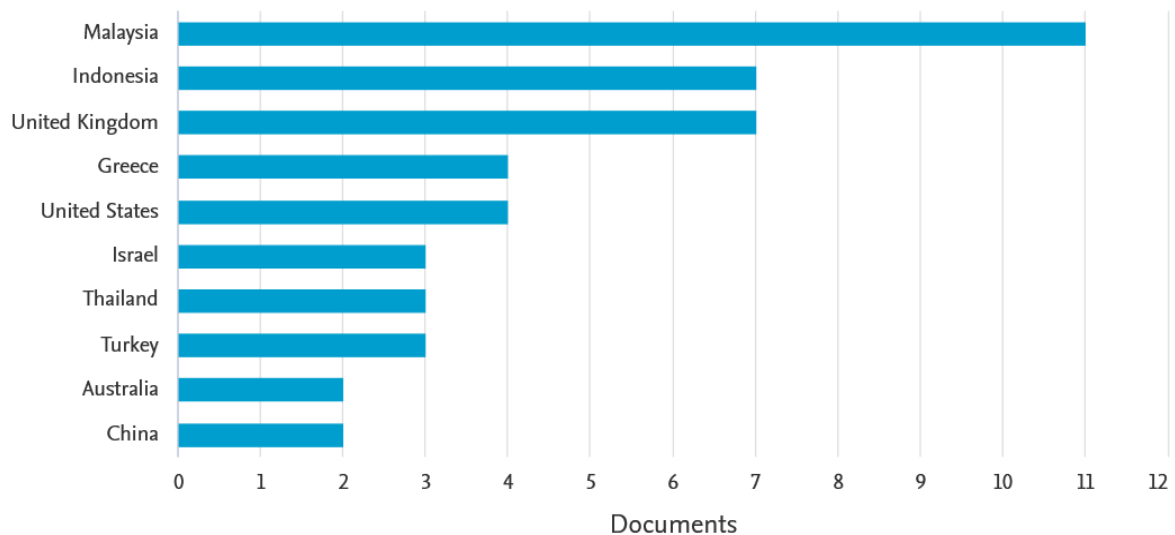

Figure 4. Publication on Digital Leadership in Education Research according to Countries

Figure 5 shows the research area subjects interested in Digital Leadership in Education. Among these subjects, "Social Sciences" is the dominating subject, generating 32.5% of publications between 2015 and 2023. Next, the subject of "computer science" is in second place, generating 20.8%; in third place is the subject of "business management" generating

9.2%; in fourth place is the subject of "engineering" generating 8.3%, while the subject "Decision Science" is in fifth place generating 5.0%.
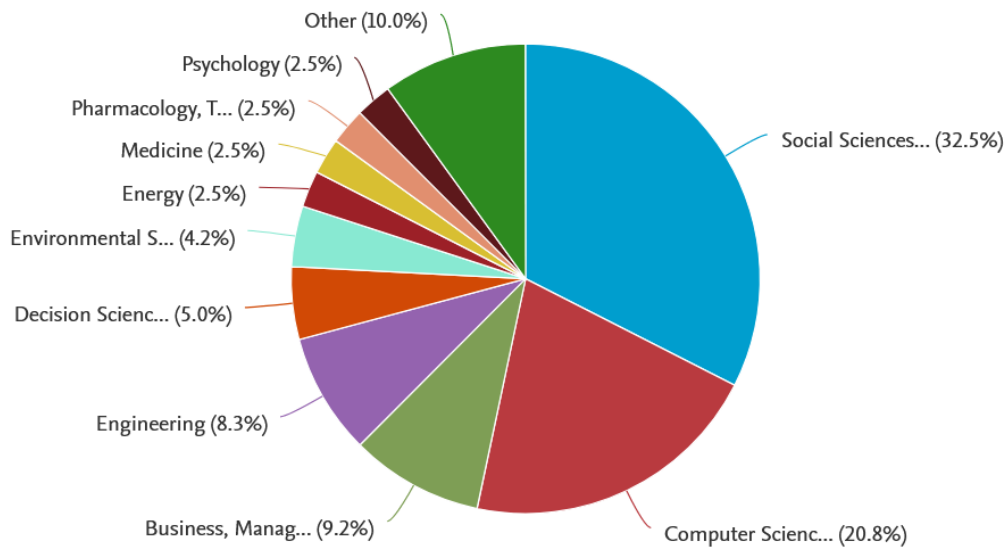
Figure 5. Publication Digital Leadership in Education According to Research Areas

Furthermore, based on the results of bibliometric analysis on affiliates that make the largest contribution, we can see in Figure 6. Among these affiliates, the State University of Malang (Indonesia), with a total of 4 publications, University Utara Malaysia (Malaysia), Open University of Israel (Israel), and University of Patras (Greece), respectively, occupy the second, third, and fourth positions with each publishing 3 publications. While the fifth to tenth place, with each publishing 2 publications, is occupied sequentially by Universiti Malaysia Terengganu (Malaysia), Universiti Sains Malaysia (Malaysia), Firat Universitesi (Turkey), Yakin Dogu Universitesi (Turkey), Dumlupinar Universitesi (Turkey), Universiti Putra Malaysia (Malaysia).
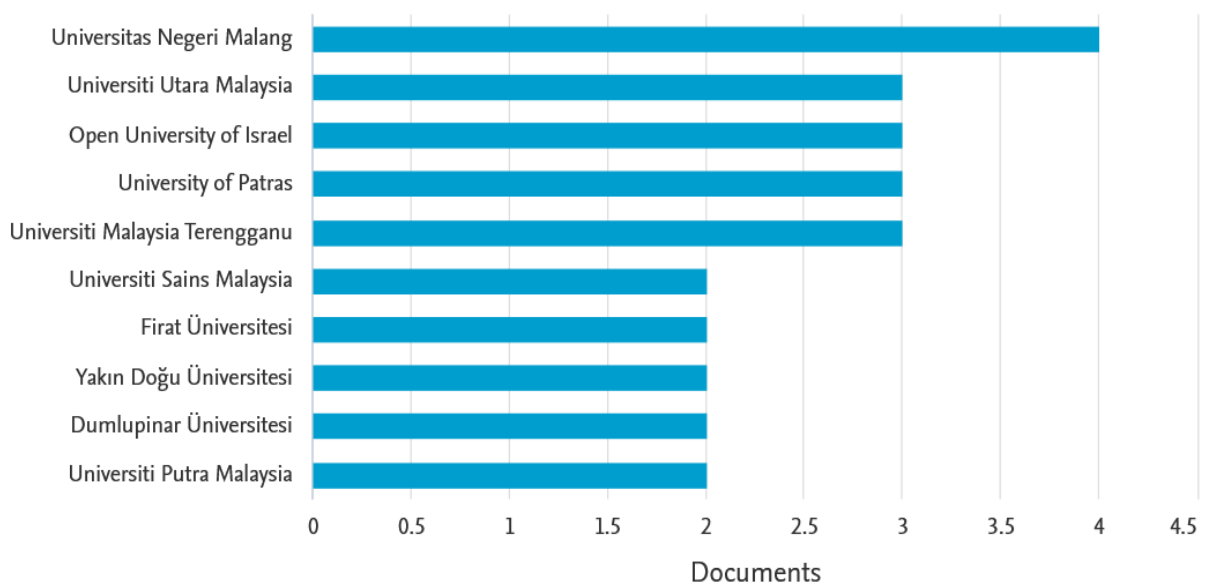
Figure 6. Publication in Digital Leadership in Education by Affiliation

3.1. Co-authorship analysis

Co-authorship analysis is a science mapping technique that assumes publications that are frequently cited together have similar themes (Waltman & Noyons, 2010). This technique presents social interactions between authors related to a particular research topic. The analysis results can be used to measure the quality of the structure in a particular research field, such as the underlying topic. In co-authorship, two publications are linked when they appear together in the reference list of another publication, and through co-authorship analysis, researchers can also find influential researchers in a particular field. Co-authorship can also be defined as a form of research collaboration involving several parties, such as researchers, institutions, organizations, and society. (Glänzel, 2014; Ponomariov & Boardman, 2016). Cooperation between researchers in each discipline has different levels. The more often the authors collaborate, the greater the collaboration in terms of research that can be achieved (Larivière, 2016; Shen et al., 2021). Differences in the level of collaboration between disciplines can be influenced by several factors, such as demographics, researcher information behavior, and gender (Thelwall, 2023).
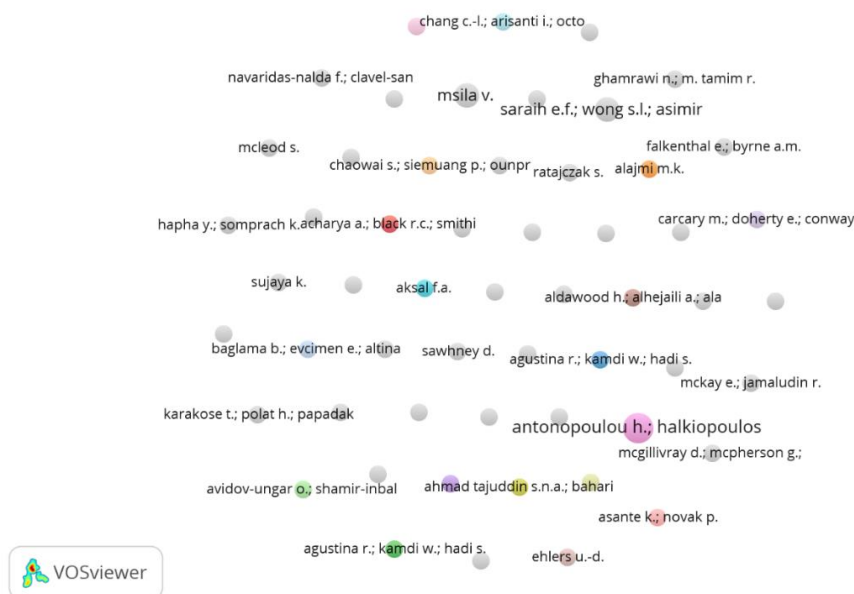

Figure 7. Co-authorship Network Map in Digital Leadership in Education

During 2015-2023, 160 authors contributed to this research topic, individually or collaboratively. Figure 7 shows a visualization of the co-authorship network; the circles represent researchers, and the network represents the relationship between researchers. The results of the co-authorship analysis do not show a network that connects the authors; it shows that authors who conduct research together are not yet available. The stronger the relationship between authors, the larger the circle formed, and vice versa. The visualization graph shows that authors are disconnected because they do not collaborate. A collection of circles without a network dominates, so that we can interpret that research collaboration on Digital Leadership in Education is still nil. This is certainly a challenge and opportunity for researchers to build collaboration. Collaborative research can empirically improve the quality of research, articles tend to be more cited when they have more authors (Aldieri, Kotsemir, & Vinci, 2018; Jeong, & Choi, 2015). In addition, collaborative research can also improve the quality of an organization's research; the more collaborative research, the quantity and quality

of the institution's research will also increase (Jeong, & Choi, 2015; Le Pennec, & Raufflet, 2018;).

3.2. Most influential researchers

The number of publications is used to indicate influential documents, while the number of citations is used to indicate influential authors and sources (Donthu, 2021; Martin, 2017). Firstly, influential documents are represented by the top 10 documents with the highest citations obtained from the Scopus database, as shown in Table 1 below.

Tabel 1. Most Influential Researchers in Digital Leadership on Education Ranked by Cites

No	Authors	Title	Source	Cites
1	Karakose T.; Polat H.; Papadakis S. (2021)	Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the covid-19 pandemic	Sustainability (Switzerland)	85
2	Carcary M.; Doherty E.; Conway G. (2016)	A dynamic capability approach to Digital transformation: A focus on key foundational themes	Proceedings of the European Conference on IS Management and Evaluation, ECIME	40
3	Aksal F.A. (2015)	Are headmasters digital leaders in school culture?	Egitim ve Bilim	32
4	Antonopoulou H.; Halkiopoulos C.; Barlou O.; Beligiannis G.N. (2021)	Transformational leadership and digital skills in higher education institutes: During the covid-19 pandemic	Emerging Science Journal	30
5	McGillivray D.; McPherson G.; Jones J.; McCandlish A. (2016)	Young people, digital media making and critical digital citizenship	Leisure Studies	29
6	Sunarsi D.; Rohaeni N.; Wulansari R.; Andriani J.; Muslimat A.; Rialmi Z.; Kustini E.; Kristianti L.S.; Rostikawati D.; Effendy A.A.; Purwanto A.; Fahlevi M. (2020)	Effect of e-leadership style, organizational commitment and service quality towards indonesian school performance	Systematic Reviews in Pharmacy	27

No	Authors	Title	Source	Cites
7	Navaridas-Nalda F.; Clavel-San Emeterio M.; Fernández-Ortiz R.; Arias-Oliva M. (2020)	The strategic influence of school principal leadership in the digital transformation of schools	Computers in Human Behavior	26
8	Hafiza Hamzah N.; Khalid M. Nasir M.; Wahab J.A. (2021)	The effects of principals' digital leadership on teachers' digital teaching during the covid-19 pandemic in malaysia	Journal of Education and e-Learning Research	24
9	Moorley C.; Chinn T. (2016)	Developing nursing leadership in social media	Journal of Advanced Nursing	20
10	AlAjmi M.K. (2022)	The impact of digital leadership on teachers' technology integration during the COVID-19 pandemic in Kuwait	International Journal of Educational Research	18

Table 1 shows that the most influential document related to the study of Digital Leadership in Education was written by Karakose, Turgut; Polat, Hakan; Papadakis, Stamatios in 2021 with the title Examining Teachers' Perspectives on School Principals' Digital Leadership Roles and Technology capabilities during the COVID-19 pandemic. This document has been cited by other relevant research 85 times. In second place is Carcary, Marian; Doherty, Eileen; Conway, Gerry, titled A Dynamic Capability Approach to Digital Transformation: A focus on key foundational themes. This document has been cited by other relevant research 40 times. Furthermore, prolific authors are represented by the top 5 authors with the highest publications, while influential authors are represented by the top 5 with the highest citations.

Tabel 2. Most productive and influential researchers in Digital Leadership on Education

The Productive Authors			The Influential Authors		
Author	Institution/ Country	Total Pub.	Author	Total Citation	Institution/Country
Antonopoulou, H.	University of Patras/Greece	3	Karakose T	85	Firat University/Turkey
Barlou, O.	University of Patras/Greece	3	Carcary M	40	Maynooth University/Ireland
Beligiannis, G.N.	University of Patras/Greece	3	Aksal F.A.	32	Near East University/Turkey
Hadi, S.	Universitas Negeri Malang/ Indonesia	3	Antonopoulou H	30	University of Patras/Greece
Halkiopoulos, C.	University of Patras/Greece	3	McGillivray D.	29	University of the West of Scotland (UWS)/United Kingdom

Of the 160 authors involved in this study, five authors are the most productive authors who have published 3 documents related to Digital Leadership in Education research; the top three are Antonopoulou, H.; Barlou, O.; Beligiannis, G.N. affiliated with the University of Patras (Greece). At the same time, Hadi, S., affiliated with the State University of Malang (Indonesia), occupies the fourth position. Halkiopoulos, C, affiliated with the University of Patras (Greece), has published 3 publications in fifth place. The influential author in the first place is Karakose T, affiliated with Firat University (Turkey), and has been cited by other relevant research about 85 times until 2023. The second place is occupied by Carcary M, affiliated with Maynooth University (Ireland), which has been cited by other relevant research about 40 times.

In the third position, Aksal, F.A. affiliated with Near East University (Turkey), has been cited by other relevant research about 32 times. In the fourth position, Antonopoulou H Berafalisi University of Patras/Greece has been cited by other relevant research about 30 times. The fifth position is occupied by McGillivray D. Berafalisi University of the West of Scotland (United Kingdom), cited by other relevant research about 29 times.

3.4. The keywords analysis Digital Leadership on Education trend topics

After the dataset was saved in CSV type using Scopus metadata, it was analyzed using the Vosviewer application by selecting the 'create a map based on text data' data option to create a network or relationship of terms based on text data. (Donthu, 2021; Zhou et al., 2022). The field terms were retrieved based on the title and abstract, while the method used to count the dataset was full counting. Cooccurrence analysis revealed that the keywords are grouped in 5 clusters or groups, as shown in Figure 8. The keywords in the clusters provide information about related research topics in the field of interest.
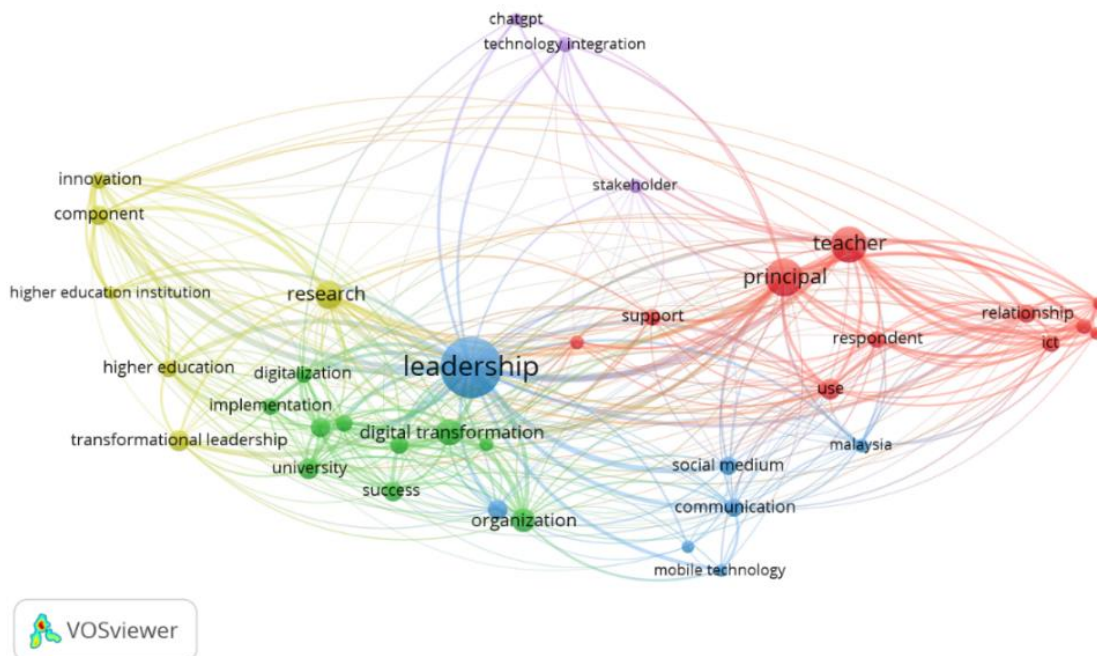

Figure 8. Network Visualization Map of Keywords' Co-occurrence

Figure 8 shows a network visualization of co-occurrence, which explains the network or relationship of one term to another in research in the Digital Leadership in Education field in 2015 - 2023. The 60 articles indexed by the Scopus database can be grouped into 6 clusters,

which can be identified through the color of each keyword node. Cluster 1 includes terms related to Digital Leadership in Education that have been researched, namely experience, ICT, principal, relationship, respondent, self-efficacy, support, teacher, teacher self-efficacy, technology leadership, and use. Cluster 2 consists of change, digital transformation, digitalization, implementation, institution, organization, and participant. Cluster 3 comprises communication, leadership, Malaysia, mobile technology, paper, and social media. Cluster 4 consists of terms such as component, higher education, higher education institution, innovation, research, and transformational leadership. Cluster 5 consists of chatgpt, stakeholder, and technology integration. After identifying the mapping using network visualization, the next step is to map and cluster Digital Leadership in Education research trends based on the year the research was published. The information obtained from the Overlay visualization results in Figure 8 can be used as a reference for identifying and detecting the state of the art from research in Digital Leadership in Education.
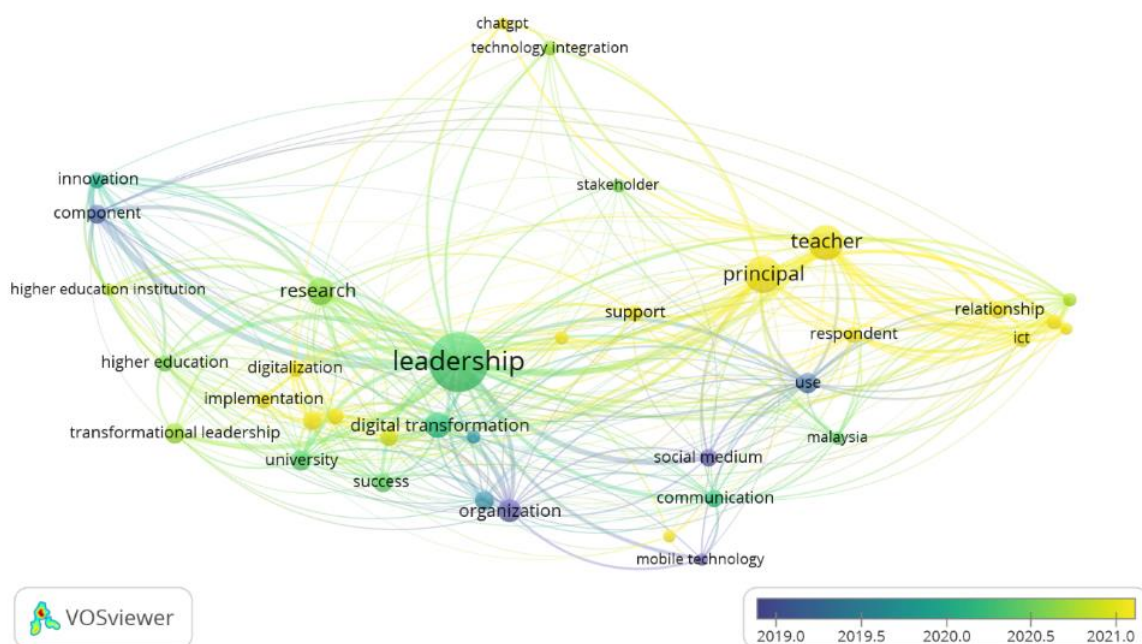

Figure 9. Overlay Visualization Map of Keywords' Co-occurrence

An overlay visualization was produced from the results of bibliometric analysis via Scopus metadata, which was visualized using Vosviewer software. In this visualization, the colors in the nodes represent keywords that indicate the year of publication. For example, the keyword' leadership' has a light green node, which means articles containing this keyword were published in 2020. Another example is the term 'principal,' which in the overlay visualization is depicted as having green nodes; this means that the term 'principal' in research on Digital Leadership in Education will only be discussed by researchers in 2021. Another example is the keyword 'organization,' which has a dark purple node color. Therefore, researchers used the keyword organization earlier in researching Digital Leadership in Education. Next is bibliometric analysis using density visualization.

From the visualization results shown in Figure 10, it can be identified that some areas have high density at one node compared to others. The level of saturation identified in the number of keywords is marked in yellow, which means that the area is a topic that has been

widely researched and indexed by Scopus. For example, the keyword leadership is lighter in color, meaning the term appears frequently in this research topic. In contrast, terms such as higher education, mobile technology, and chatgpt have a faint color, meaning they are rarely discussed in research on this topic.
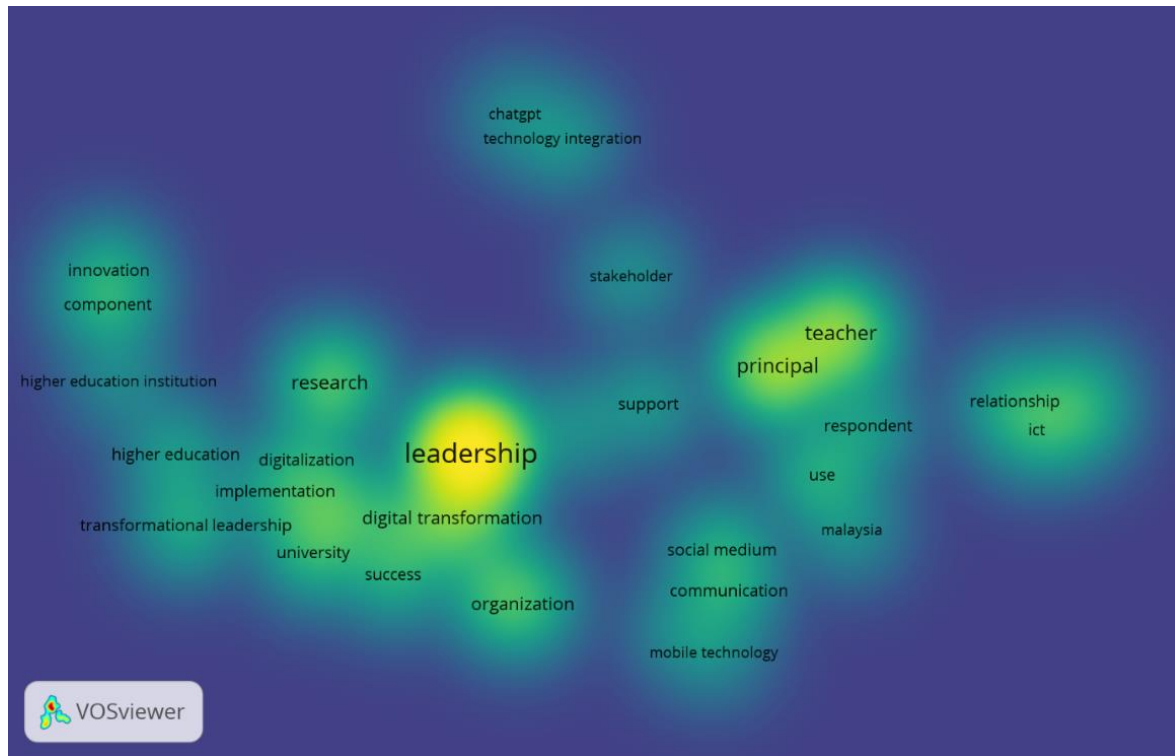

Figure 10. Density Visualization Map of Keywords' Co-occurrence

Although research on the topic of Digital Leadership in Education is still relatively small, this is an opportunity for other researchers to continue to develop this research trend through journal publications or proceedings. This can provide opportunities to research this topic; for example, ICT keywords are linked to leadership, or mobile technology is linked to principals. The bibliometric analysis on the density visualization showing low strain and intensity shows that research is still relatively low; this opens up opportunities to conduct research, and this topic is still very broad to be researched.

4. CONCLUSION

The results of an analysis of 60 publications on Digital Leadership in Education between 2015 and 2023 published by Scopus. We first conducted a quantitative metadata analysis to determine results based on the number of publications and citations, affiliations, countries, subject areas, and authors. Data analysis showed that the development of publications related to Digital Leadership in Education was relatively constant from 2015 to 2016 and experienced a decline from the beginning of 2017 to 2018. We can observe an increase in publications from 2019 to 2022.

Countries such as Malaysia, Indonesia, the United Kingdom, Greece, and the United States produced more publications. Israel, Thailand, Turkey, Australia, and China follow them. After qualitative analysis, it was seen that although Malaysia was one of the countries that published more papers, there were other countries with the most influential researchers.

Even so, Turkey still produces the most influential researcher with the most number of publication citations, with a researcher named Karakose T.

In addition, the top research subject interested in Digital Leadership in Education is "Social Sciences," which produced approximately one-half the number of publications of all subject areas between 2015 and 2023. Meanwhile, the university with the largest contribution is Universitas Negeri Malang (Indonesia). In second place is Universiti Utara Malayasia (Malaysia). The third to fifth directorates include Open University (Israel), University of Patra (Greece), and Universiti Terengganu Malaysia (Malaysia).

Of the 160 authors involved in this study, there are five top authors who each published three articles related to Digital Leadership in Education research; the top three are Antonopoulou, H.; Barlou, O.; Beligiannis, G.N. affiliated with the University of Patras (Greece). At the same time, Hadi, S., affiliated with the State University of Malang (Indonesia), occupies the fourth position. In fifth place, Halkiopoulos, C, affiliated with the University of Patras (Greece), has published 3 Newby publications. In contrast, the influential author in the first place is Karakose T, affiliated with Firat University (Turkey), and has been cited by other relevant research about 85 times until 2023. While second place is occupied by Carcary M, affiliated with Maynooth University (Ireland), it has been cited by other relevant research about 40 times. In the third position, Aksal, F.A Berafalisi Near East University (Turkey), has been cited by other relevant research about 32 times. In the fourth position, Antonopoulou H Berafalisi University of Patras(Greece) has been cited by other relevant research about 30 times. While the fifth position is occupied by McGillivray D., Berafalisi University of the West of Scotland (United Kingdom) has been cited by other relevant research about 29 times.

Furthermore, collaboration between researchers who examine Digital Leadership in Education is relatively nil, even though the trend in the number of publications in the last five years has increased significantly. This is an opportunity to open up opportunities for collaboration between authors.

This study has limitations. Firstly, researchers only used Scopus to collect data. Second, publications with in-press status were used as part of the research data. However, these limitations will not affect the results identified in this study. In addition, we associated digital leadership with education and school in the data search. However, the data collection is relatively the same because research on Digital Leadership in Education is relatively new to be published by Scopus, where the initial publishing period began in 2015.

REFERENCES

Aggarwal, S., & Kumar, A. (2022). Dealing with a new normal 'e-leadership': A Study using bibliometric analysis and content analysis. *Vision*, *0*(0), 1-14.

Aksal, F. A. (2015). Are headmasters digital leaders in school culture?. *Egitim ve Bilim*, *40*(182), 77-86.

AlAjmi, M. K. (2022). The impact of digital leadership on teachers' technology integration during the COVID-19 pandemic in Kuwait. *International Journal of Educational Research*, *112*(101928), 1-10.

Aldieri, L., Kotsemir, M., & Vinci, C. P. (2018). The impact of research collaboration on academic performance: An empirical analysis for some European countries. *Socio-Economic Planning Sciences*, *62*, 1-40.

Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2021). Transformational leadership and digital skills in higher education institutes: during the COVID-19 pandemic. *Emerging science journal*, *5*(1), 1-15.

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative science studies*, *1*(1), 377-386.

Carcary, M., Doherty, E., & Conway, G. (2016, September). A dynamic capability approach to digital transformation: a focus on key foundational themes. In *The European Conference on Information Systems Management* (p. 20). Academic Conferences International Limited.

Cortellazzo, L., Bruni, E., & Zampieri, R. (2019). The role of leadership in a digitalized world: A review. *Frontiers in psychology*, *10*(1938), 1-21.

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of business research*, *133*, 285-296.

Glänzel, W. (2014). Analysis of co-authorship patterns at the individual level. *Transinformação*, *26*(3), 229-238.

Hamzah, N. H., Nasir, M. K. M., & Wahab, J. A. (2021). The effects of principals' digital leadership on teachers' digital teaching during the COVID-19 Pandemic in Malaysia. *Journal of Education and E-Learning Research*, *8*(2), 216-221.

Harto, B., Wibowo, L. A., & Yuniarsih, T. (2022, July). Bibliometric analysis of strategic digital leadership to boost innovation in organization. In *6th Global Conference on Business, Management, and Entrepreneurship (GCBME 2021)* (pp. 429-435). Atlantis Press.

Hsieh, C. C., & Hsu, C. H. (2022). The development of VOSviewer and its application in educational research. *School Administrators*, (141), 149-166.

Ivančić, L., Vukšić, V. B., & Spremić, M. (2019). Mastering the digital transformation process: Business practices and lessons learned. *Technology Innovation Management Review*, *9*(2), 36-50.

Jeong, S., & Choi, J. Y. (2015). Collaborative research for academic knowledge creation: How team characteristics, motivation, and processes influence research impact. *Science and Public Policy*, *42*(4), 460-473.

Karakose, T., Polat, H., & Papadakis, S. (2021). Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the COVID-19 pandemic. *Sustainability*, *13*(23), 1-20.

Klein, M. (2020). Leadership characteristics in the era of digital transformation. BMIJ, *8*(1), 883-902.

Kulkanjanapiban, P., & Silwattananusarn, T. (2022). Comparative analysis of Dimensions and Scopus bibliographic data sources: An approach to university research productivity. *International Journal of Electrical and Computer Engineering (IJECE)*, *12*(1), 706-720.

Kumar, S., Marrone, M., Liu, Q., & Pandey, N. (2020). Twenty years of the International Journal of Accounting Information Systems: A bibliometric analysis. *International Journal of Accounting Information Systems*, *39*, 100488.

Larivière, V., Desrochers, N., Macaluso, B., Mongeon, P., Paul-Hus, A., & Sugimoto, C. R. (2016). Contributorship and division of labor in knowledge production. *Social studies of science*, *46*(3), 417-435.

Le Pennec, M., & Raufflet, E. (2018). Value creation in inter-organizational collaboration: An empirical study. *Journal of Business Ethics*, *148*, 817-834.

Ma, K., & Yang, B. (2014). A simple scheme for bibliography acquisition using DOI content negotiation proxy. *The Electronic Library*, *32*(6), 806-824.

Martín-Martín, A., Orduña-Malea, E., Harzing, A. W., & López-Cózar, E. D. (2017). Can we use Google Scholar to identify highly-cited documents?. *Journal of informetrics*, *11*(1), 152-163.

McAllister, J. T., Lennertz, L., & Atencio Mojica, Z. (2022). Mapping a discipline: A guide to using VOSviewer for bibliometric and visual analysis. *Science & Technology Libraries*, *41*(3), 319-348.

McGillivray, D., McPherson, G., Jones, J., & McCandlish, A. (2016). Young people, digital media making and critical digital citizenship. *Leisure Studies*, *35*(6), 724-738.

Moorley, C., & Chinn, T. (2016). Developing nursing leadership in social media. *Journal of advanced nursing*, *72*(3), 514-520.

Mukherjee, D., Lim, W. M., Kumar, S., & Donthu, N. (2022). Guidelines for advancing theory and practice through bibliometric research. *Journal of Business Research*, *148*, 101-115.

Navaridas-Nalda, F., Clavel-San Emeterio, M., Fernández-Ortiz, R., & Arias-Oliva, M. (2020). The strategic influence of school principal leadership in the digital transformation of schools. *Computers in Human Behavior*, *112*, 106481.

Ponomariov, B., & Boardman, C. (2016). What is co-authorship?. *Scientometrics*, *109*, 1939-1963.

Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world. *Publications*, *9*(1), 1-59.

Shen, H., Xie, J., Li, J., & Cheng, Y. (2021). The correlation between scientific collaboration and citation count at the paper level: a meta-analysis. *Scientometrics*, *126*(4), 3443-3470.

Sunarsi, D., Rohaeni, N., Wulansari, R., Andriani, J., Muslimat, A., Rialmi, Z., ... & Fahlevi, M. (2020). Effect of e-leadership style, organizational commitment and service quality towards indonesian school performance. *Syst. Rev. Pharm*, *11*, 472-481.

Temelkova, M. (2020). Digital leadership added value in the digital smart organizations. *Journal of Engineering Science and Technology Review*, 252-257.

Thelwall, M., Kousha, K., Abdoli, M., Stuart, E., Makita, M., Wilson, P., & Levitt, J. (2023). Why are coauthored academic articles more cited: Higher quality or larger audience?. *Journal of the Association for Information Science and Technology*, *74*(7), 791-810.

Todeschini, R., & Baccini, A. (2016). *Handbook of bibliometric indicators: Quantitative tools for studying and evaluating research*. John Wiley & Sons.

Umah, E. C., Imron, A., Hadi, S., & Praherdhiono, H. (2023). Madrasah principal digital leadership innovation in digital learning transformation. *Revista de Gestão Social e Ambiental*, *17*(3), 1-16.

Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *scientometrics*, *84*(2), 523-538.

Waltman, L., Van Eck, N. J., & Noyons, E. C. (2010). A unified approach to mapping and clustering of bibliometric networks. *Journal of informetrics*, *4*(4), 629-635.

Yusof, M. R., Yaakob, M. F. M., & Ibrahim, M. Y. (2019). Digital leadership among school leaders in Malaysia. *Int. J. Innov. Technol. Explor. Eng*, *8*(9), 1481-1485.

Zhou, X., Zhou, M., Huang, D., & Cui, L. (2022). A probabilistic model for co-occurrence analysis in bibliometrics. *Journal of Biomedical Informatics*, *128*, 104047.