

The Effects of Digital Leadership on Teacher's Use of ICT: A Bibliometric Analysis

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Abstract

This research provides a comprehensive analysis of digital leadership and teachers' use of ICT from 2013 to 2023. This review explores how digital leadership influences teachers' use of ICT. Using PRISMA, a bibliometric analysis was performed on studies that relate to digital leadership and the use of ICT in teaching. The Scopus search yielded 8,797 publications, which were narrowed to 2,161 relevant articles. The study reviews publishing trends, contributions from leading countries and institutions, prolific authors, and key terms in the field. Data spanning a decade reveal a significant increase in research activity after 2019, influenced by technological advances and the global COVID-19 pandemic. Prolific authors such as Joe Tondior and Cheng Seng Zhai and dominant key terms such as "ICT" and "e-learning" shape the discourse. Spanish institutions dominate research output, while countries such as Malaysia, the United States, Indonesia, South Africa and India make notable contributions. There is dearth of research on digital leadership and ICT integration in Middle Eastern education. The global push for digital leadership in education signals opportunities for future advancement, while the scarcity of research on this topic in Middle Eastern education underscores the critical need for collaborative scholarly efforts to fill this gap and develop tailored solutions for the region.

Keywords: Digital Leadership, Teachers' Use ICT, e-Learning, Educational Technology, Digital Competences, ICT Integration

Introduction

Within the domain of education, the incorporation of Information and Communication Technologies (ICT) has witnessed a surge in adoption, profoundly altering pedagogical methodologies on a global scale (Akram et al., 2022). This transformation facilitated by ICT has rendered educational practices more dynamic and efficient Lin et al (2017), leveraging an array of tools applicable across both conventional classroom settings and virtual learning environments, thereby fostering an engaged and participatory pedagogical atmosphere

(Jogezai et al., 2021). Incorporation of technology into instructional practices not only elevates the caliber of teaching Akram & Yang (2021) but also facilitates skill development, motivation enhancement, and efficient knowledge acquisition among students (Chen et al., 2018). Central to the successful implementation of ICT in educational settings is the role of digital leadership, which encompasses the strategies, practices, and competencies employed by educational leaders to leverage digital technologies effectively (Karakose et al., 2021).

The International Society for Technology in Education Standards for Administrators ISTE-A (2009) delineates the multifaceted responsibilities conferred upon educational leaders in harnessing technology to enhance the efficacy of educational institutions, spanning teaching, learning, and administrative domains (Weng & Tang, 2014). While these standards have been utilized as evaluative instruments to investigate the interconnection between technology leadership strategies and institutional effectiveness, there remains a dearth of research focusing on the identification of specific performance metrics within the ISTE-A framework (Zhong, 2017). Consequently, a conspicuous gap persists in understanding the intricate facets of digital leadership practices and their tangible manifestations within educational contexts, particularly concerning the utilization of ICT among teachers, notably within the realm of K-12 education.

Educational leaders, including principals, are responsible for acquiring proficiency in digital technology skills while promoting a culture that emphasises leadership qualities related to digital technology. Simultaneously, educators are encouraged to get ICT and digital technology skills, enabling the smooth incorporation of digital advancements into teaching methods (Hamzah et al., 2021). The interdependent connection between digital leadership and teacher competences is crucial in guiding significant improvements aimed at improving students' academic achievement through the strategic use of digital technology.

Mei Wei et al (2016) argue that digital school leaders have a crucial impact on how teachers use ICT in education. They do this by taking strategic actions such as providing visionary leadership, organising personalised professional development, effectively allocating resources, and promoting a culture of collaboration and support among educators. Through their involvement in these activities, digital leaders enable teachers to effectively utilise ICT technologies to better their teaching methods, ultimately leading to enhanced student learning outcomes in the digital era. In contrast, according to AlAjmi's (2022) research, digital leadership exhibited by school administrators had a favourable impact on teachers' use of technology during the COVID-19 epidemic. This discovery emphasises the direct and measurable influence of digital leadership in helping instructors adjust to remote and hybrid learning settings.

Saeed & Kang's (2024) study emphasises the significant impact of digital leadership on teachers' performance. It promotes the adoption of technology, improves digital literacy, supports innovative teaching methods, facilitates collaboration, and fosters a positive digital culture in educational institutions. Through acknowledging the importance of digital leadership, educational institutions may enable instructors to adeptly navigate the digital terrain and equip students with the necessary skills for the challenges of the 21st century. These viewpoints collectively highlight the diverse impact of digital leadership on teachers' utilisation of ICT, emphasising its role in propelling educational change and promoting creativity in teaching and learning methods.

Gaining insight into the impact of digital leadership on teachers' utilisation of ICT is crucial for guiding leadership strategies, shaping policy choices, and implementing professional development programmes that aim to improve technology-integrated teaching and learning

experiences. This bibliometric analysis aims to methodically examine and combine the existing literature on this subject, offering a thorough summary of research patterns, thematic focuses, and knowledge contributions in the field.

This bibliometric analysis aims to examine and clarify significant trends, patterns, and influencers in the academic discussion on digital leadership and its connection with teachers' utilisation of ICT from 2013 to 2023. This study intends to provide important insights into the changing environment of digital leadership in education by analysing the distribution of publications, identifying key nations and educational institutions, highlighting prolific writers, and uncovering prominent research phrases. These insights are important for educational policymakers, administrators, academics, and practitioners who are working to fully utilise ICT to improve teaching and learning outcomes. This research aims to enhance the scholarly discussion on digital learning by examining the intricate connection between digital leadership and the incorporation of ICT into teaching methods. By employing this methodology, the study seeks to improve educational experiences in this particular field. Hence, the main objective of this bibliometric assessment was to tackle the following research inquiries:

What is the prevalence of Digital leadership in publications on teachers' utilisation of ICT from 2013 to 2023?

Which countries exert the greatest influence on digital leadership in publications from 2013 to 2023?

Which educational institutions have made the most significant contributions to the study of Digital leadership in publications on teachers' use of ICT between 2013 and 2023?

Which authors have made the most significant contributions to the field of digital leadership in publications on teachers' use of ICT from 2013 to 2023?

What are the primary research topics related to Digital leadership in publications on teachers' use of ICT from 2013 to 2023?

Method

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations are followed by the current bibliometric investigation (Moher, 2009). Its main goal is to carefully identify the body of research on the relationship between teachers' ICT use and digital leadership. This entails a thorough analysis of notable years, nations, educational establishments, and researchers that have contributed to this field in order to identify recurring themes and important vocabulary in this field of study.

VosViewer worked in concert with the PRISMA architecture to provide essential data visualisation and analysis tools. VosViewer automates the construction and maintenance of bibliometric networks, which might include researchers, publications, journals, or other entities backed by citation, co-authorship, and bibliographic coupling relationships. VosViewer made it easier to map and analyse complex e-learning research networks, which helped to visualise trends, pinpoint scholarly subfields, and locate eminent journals, publications, and authors. Key research trends and patterns in e-learning were identified through comprehensive data analysis made possible by its interactive graphical user interface (GUI) and ability to handle large datasets. VosViewer improved knowledge of the worldwide effects of e-learning and scholarly research dynamics by classifying publications geographically and drawing boundaries between authors and institutions in collaborative connections.

The approaches used in this work will be covered in detail in this section, with an emphasis on how the PRISMA framework was used as the main structural framework for the investigation.

Identification

This review was performed using the Scopus database on May 4th, 2024. The main goal was to investigate the relationship between digital leadership and teachers' confidence in using ICT. There are three main keywords were used for instance, e-learning and teacher use of ICT and leadership, and the query used for this is TITLE-ABS-KEY (e-learning OR teacher OR leadership OR use AND of AND ict). This search has been conducted for the last twelve years, as this query was used AND PUBYEAR > 2012 AND PUBYEAR < 2024. A specific set of criteria, both for inclusion and exclusion, was employed in this review. Table (1) outlines these criteria in detail.

Table (1)

Inclusion and exclusion criteria

Inclusion criteria	exclusion criteria
e-learning and teacher use of ICT and leadership	Any other keywords.
Articles from 2013- 2023	Any research before 2013 was excluded, and any research in 2024.
Only articles in English language	Any other languages
Only articles	Conference papers, books, thesis
Arts, and social science	Any other field.

Screening

The initial search on the Scopus database retrieved 8,797 documents. After applying the inclusion and exclusion criteria, this evaluation included only 2,161 documents, while 6,636 were removed from the search.

Eligibility

Only articles in the field of arts and social science and humanites were included in this search, following the query AND (LIMIT-TO (SUBJAREA , "ARTS") OR LIMIT-TO (SUBJAREA , "SOCI")). Moreover, only articles were included AND (LIMIT-TO (DOCTYPE , "ar")). A set of “exact keywords” were used to provide more precise results as follow, “e-learning, ICT, Teaching, education, Information And Communication Technologies , Teachers, Learning, Digital Competence, Educational Technology, Technology, ICT Integration, Teacher, Online Learning, Technology Integration, Information And Communication Technology (ICT), Information Technology, Distance Education, Teachers, Distance Learning, Information Communication Technology, Ict, E-Learning, Digital Technologies, Digital Skills, Leadership, Information And Communications Technology, Information And Communication Technologies (ICT), ICT Skills, Integration, ICT Use, Technological Pedagogical Content Knowledge, Online Education, Technology Adoption, ICT Literacy, ICTs, E - Learning, ICT Competence, ICT Competencies and ICT Tools, as follow; AND (LIMIT-TO (EXACTKEYWORD , "ICT") OR LIMIT-TO (EXACTKEYWORD , "E-learning") OR LIMIT-TO (EXACTKEYWORD , "Teaching") OR LIMIT-TO (EXACTKEYWORD , "Education") OR LIMIT-TO (EXACTKEYWORD , "Information And Communication Technologies") OR LIMIT-TO (EXACTKEYWORD ,

"Information And Communication Technology") OR LIMIT-TO (EXACTKEYWORD , "Teachers") OR LIMIT-TO (EXACTKEYWORD , "Learning") OR LIMIT-TO (EXACTKEYWORD , "Digital Competence") OR LIMIT-TO (EXACTKEYWORD , "Educational Technology") OR LIMIT-TO (EXACTKEYWORD , "Technology") OR LIMIT-TO (EXACTKEYWORD , "Engineering Education") OR LIMIT-TO (EXACTKEYWORD , "ICT Integration") OR LIMIT-TO (EXACTKEYWORD , "Teacher") OR LIMIT-TO (EXACTKEYWORD , "Online Learning") OR LIMIT-TO (EXACTKEYWORD , "Technology Integration") OR LIMIT-TO (EXACTKEYWORD , "Information And Communication Technology (ICT)") OR LIMIT-TO (EXACTKEYWORD , "Information Technology") OR LIMIT-TO (EXACTKEYWORD , "Distance Education") OR LIMIT-TO (EXACTKEYWORD , "Teachers") OR LIMIT-TO (EXACTKEYWORD , "Distance Learning") OR LIMIT-TO (EXACTKEYWORD , "Information Communication Technology") OR LIMIT-TO (EXACTKEYWORD , "Ict") OR LIMIT-TO (EXACTKEYWORD , "E-Learning") OR LIMIT-TO (EXACTKEYWORD , "Digital Technologies") OR LIMIT-TO (EXACTKEYWORD , "Digital Skills") OR LIMIT-TO (EXACTKEYWORD , "Leadership") OR LIMIT-TO (EXACTKEYWORD , "Information And Communications Technology") OR LIMIT-TO (EXACTKEYWORD , "Information And Communication Technologies (ICT)") OR LIMIT-TO (EXACTKEYWORD , "ICT Skills") OR LIMIT-TO (EXACTKEYWORD , "Integration") OR LIMIT-TO (EXACTKEYWORD , "ICT Use") OR LIMIT-TO (EXACTKEYWORD , "Technological Pedagogical Content Knowledge") OR LIMIT-TO (EXACTKEYWORD , "Online Education") OR LIMIT-TO (EXACTKEYWORD , "Technology Adoption") OR LIMIT-TO (EXACTKEYWORD , "ICT Literacy") OR LIMIT-TO (EXACTKEYWORD , "ICTs") OR LIMIT-TO (EXACTKEYWORD , "E - Learning") OR LIMIT-TO (EXACTKEYWORD , "ICT Competence") OR LIMIT-TO (EXACTKEYWORD , "ICT Competencies") OR LIMIT-TO (EXACTKEYWORD , "ICT Tools"). Lastly, only articles in English language were included as follow; AND (LIMIT-TO (LANGUAGE , "English")). Figure 1 Prisma framework is the main framework for this study.

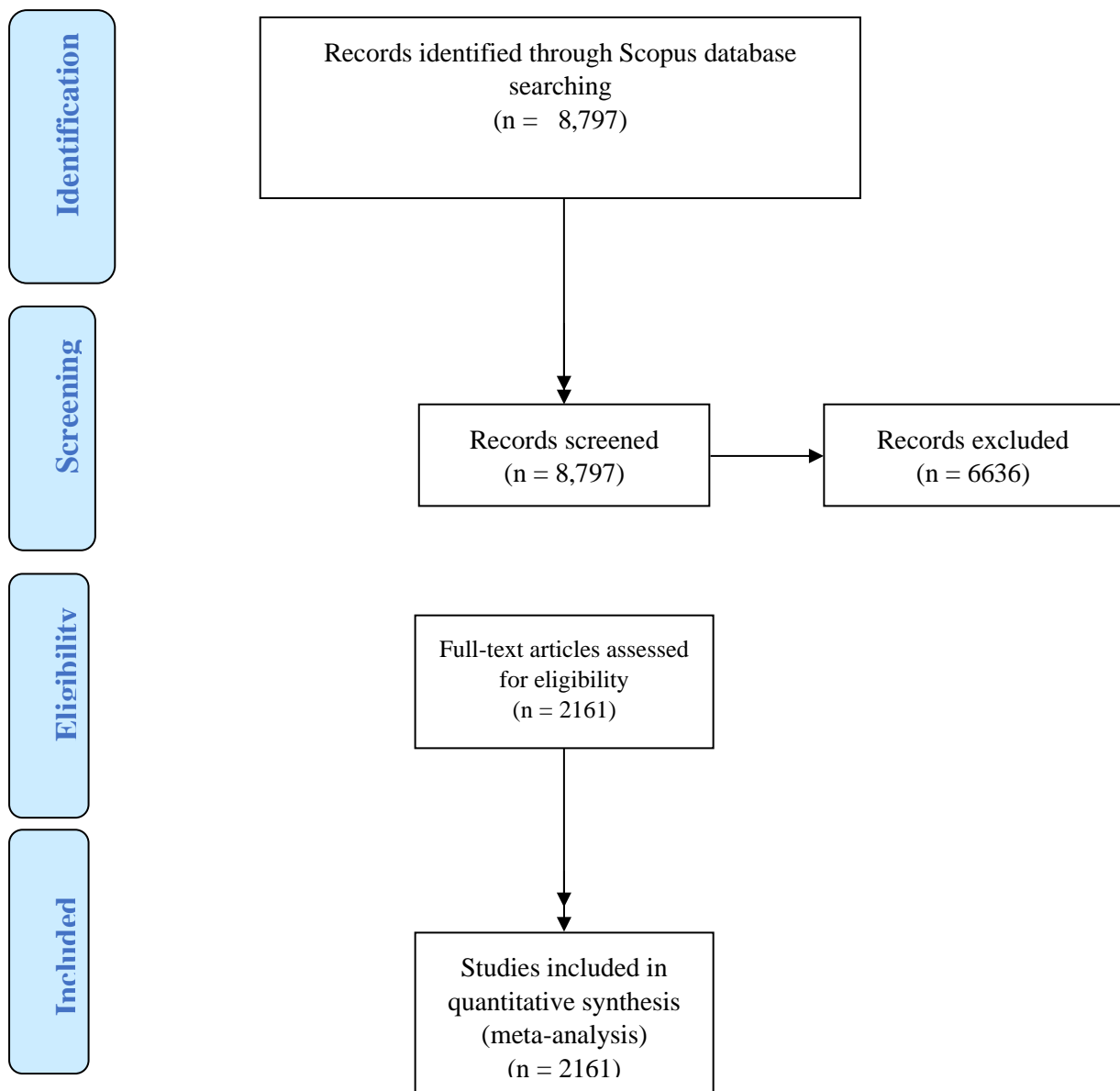


Figure 1: PRISMA Framework

Result

The study examined bibliometric research findings on the relationship between digital leadership and educators' use of ICT. The study encompassed a compilation of research conducted between 2012 and 2023, revealing unique insights and specialised themes within this particular field. This assessment covered important subject areas, prominent authors, significant journals and nations, top academic institutions, publication patterns, and search terms. The aim of this synthesis is to determine the key factors driving scientific investigation, outline the development of e-learning research, and provide a comprehensive perspective on global initiatives to understand the impact of digital leadership settings on educators' use of ICT.

The Distribution by Years

The study of the presented data indicates a clear pattern of increasing academic output from 2013 to 2023 in publications on teachers' use of ICT, which addresses the research question regarding the distribution of digital leadership. The increasing number of publications on this topic indicates a clear rising trend, reflecting a growing interest and emphasis on the role of digital leadership in influencing educators' use of ICT.

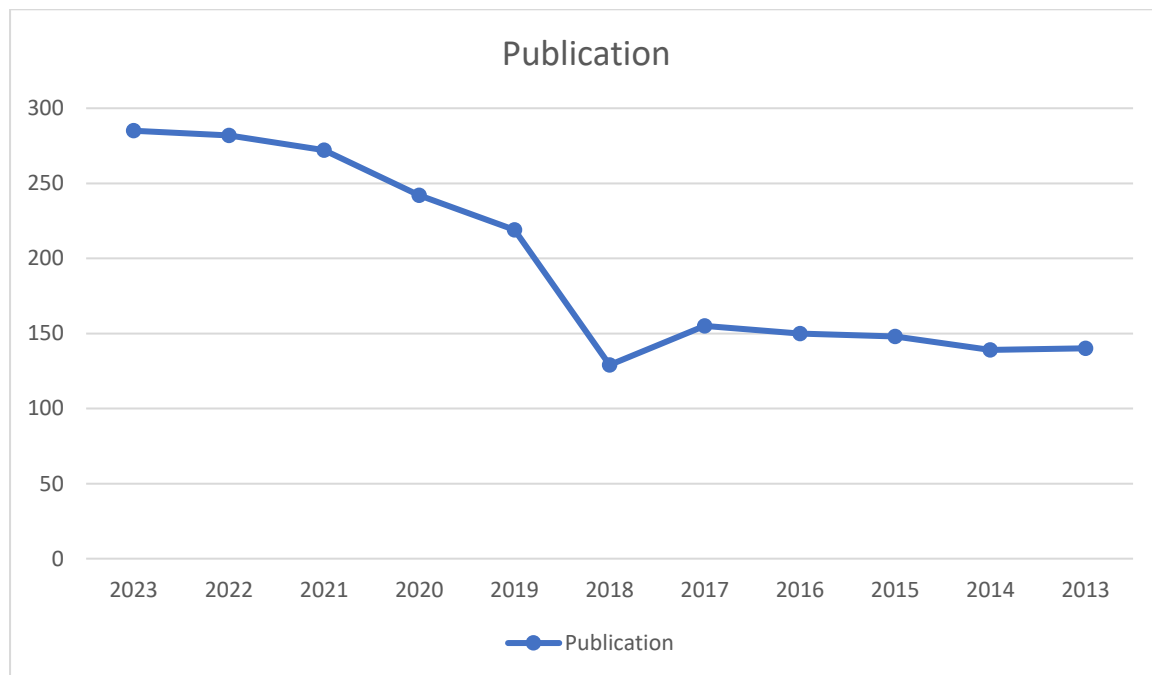


Figure (1): Publications by years

The data provides a thorough analysis of the patterns in publications related to digital leadership and the use of ICT by educators from 2013 to 2023. An evident pattern that has been seen is the consistent rise in the quantity of published works throughout time, particularly during the latter portion of the examined timeframe. This indicates an increasing interest and research effort in comprehending the relationship between digital leadership practices and the incorporation of ICT in educational environments. The significant increase in publications starting from 2019 suggests a rapid rate of research, possibly influenced by technological improvements, developing teaching methods, and growing awareness of the significance of digital skills in education. Furthermore, considering the repercussions and results of the Covid-19 pandemic.

Moreover, the data highlights the worldwide importance of the subject, as seen by the wide variety of publications spanning several years. This represents a global endeavour to investigate the various facets of digital leadership and how it affects educators' use of ICT. Analysing bibliometric research data helps to uncover important trends and patterns, as well as gain insights into the development of e-learning research and the global effort to understand the dynamics of digital leadership environments in education. Having a comprehensive perspective like this helps guide future research directions, influence legislative decisions, and enhance educational practices in the digital era.

The most Significant Countries

In order to investigate the second study question, which is to identify the countries that have the most influence on digital leadership in terms of teachers' use of ICT, an analysis of the available data reveals a wide-ranging worldwide impact, as shown in Figure 3. Examining the dispersion of publications by country offers useful insights into the worldwide landscape of digital leadership in education, specifically in terms of the incorporation of ICT in teaching methods. Spain stands itself as a significant contributor with a considerable number of papers (343), demonstrating a firm dedication to investigating the connections between ICT and pedagogy. This indicates a developed interest in using technology to improve educational results, demonstrating Spain's proactive approach to promoting digital leadership in education.

Malaysia has also joined in with a significant number of publications (127), which shows a rising focus on digital leadership and the strategic integration of ICT in educational settings. Malaysia acknowledges the significant impact that technology can have on teaching and learning, and is committed to fostering innovative educational methods through the incorporation of technology. Similarly, the United States has a substantial presence in the field with 124 publications, which highlights its ongoing dedication to promoting digital leadership initiatives. The United States, with its extensive history of technical advancement, remains a key player in influencing the worldwide conversation on the integration of ICT in education.

Indonesia and South Africa, two emerging nations, demonstrate a strong desire for digital leadership and the incorporation of ICT in education, as indicated by their publication counts of 107 and 101, respectively. While the number of publications from less industrialised nations may be lesser compared to more developed countries, their participation suggests a notable shift towards embracing technology-based education approaches. In addition, the inclusion of India, with 94 publications, highlights the global influence of digital education programmes. This demonstrates a conscious effort to reduce the disparity in access to digital resources and harness the potential of ICT to establish equitable and inclusive learning environments.

The inclusion of other nations in the dissemination of publications underscores the worldwide importance of digital leadership in education. Each country makes a unique contribution to the global conversation on incorporating ICT into teaching techniques, either through extensive research or nascent initiatives. This underscores the necessity for cooperative endeavours centred on harnessing the transformative capabilities of technology to empower educators, enrich learning experiences, and ultimately foster holistic development in the digital age.

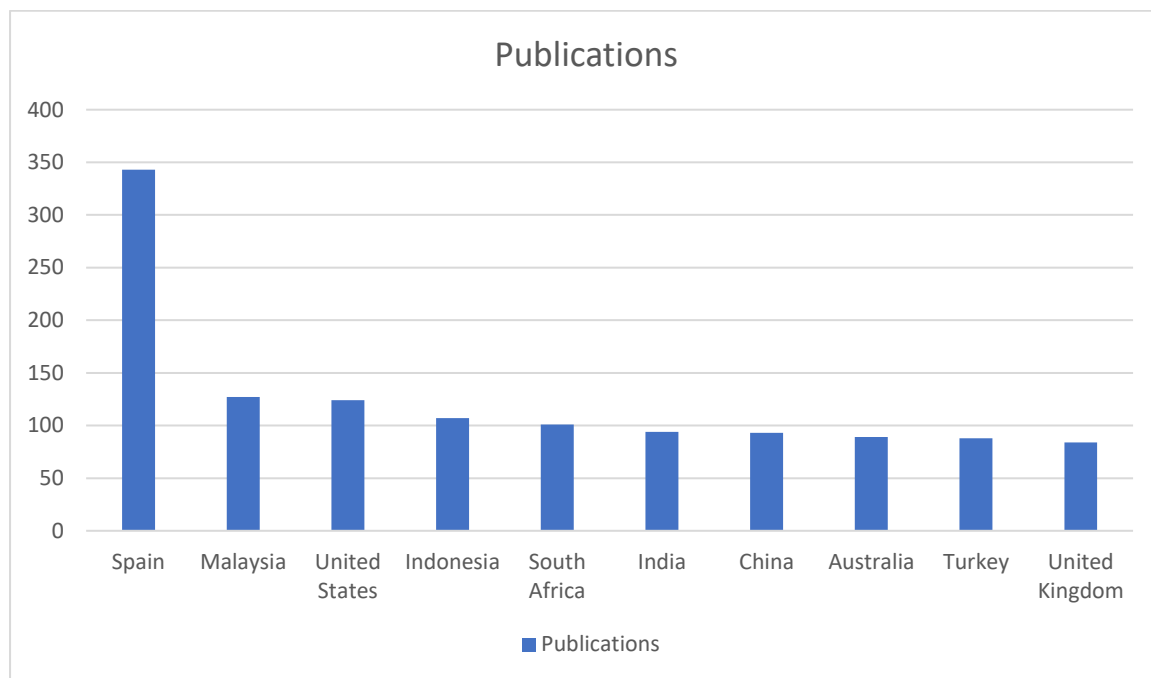


Figure (2): Publications by country

The most significant educational institutions

The data provided pertains to the fourth research question, which inquires about the educational institutions that have made significant contributions to the study of digital leadership in teachers' utilisation of ICT. Identifies and emphasises numerous crucial institutions. The information can be found in Figure 5, Table (2), and Figure 4.

Table (2)

The most significant educational institutions in Digital leadership in teachers' use of ICT research

#	educational institutions	TP	Most cited publications	Time cited
1	Universidad de Granada	36	Teacher training in lifelong learning-the importance of digital competence in the encouragement of teaching innovation	115
2	Universidad de Sevilla	34	Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure	237
3	Universiti Kebangsaan Malaysia	27	The use of information and communication technology (ICT) in teaching ESL writing skills	39
4	Universidad de Salamanca	23	Digital competence of early childhood education teachers: attitude, knowledge and use of ICT	94
5	Universidad de Málaga ²¹	21	Teacher digital literacy: The indisputable challenge after covid-19	107

6	Nanyang Technological University19	19	A review of technological pedagogical content knowledge	323
7	Univerza v Ljubljani19	19	Attributes of digital natives as predictors of information literacy in higher education	101
8	Universitat de València18	18	Teachers' information and communication technology competences: A structural approach	136
9	Universiti Malaya18	18	Teaching and learning with technology: Effectiveness of ICT integration in schools	335
10	National Institute of Education	17	TPACK-in-Action: Unpacking the contextual influences of teachers' construction of technological pedagogical content knowledge (TPACK)	117

TP= Total publications

Several educational institutions have made noteworthy contributions to the study of Digital leadership in publications on teachers' use of ICT from 2013 to 2023. The University of Granada is at the forefront with 36 total publications, showcasing a strong dedication to studying the impact of digital competence on promoting classroom innovation. The University of Seville attentively examines 34 papers that specifically investigate the elements that influence the utilisation of ICT in secondary education classes. These educational establishments, situated in Spain, demonstrate the nation's commitment to promoting digital leadership in the field of education.

Universiti Kebangsaan Malaysia has established itself as a significant contributor with 27 papers, focusing on the application of ICT in enhancing the teaching of ESL writing abilities. The accomplishments of this school highlight Malaysia's dedication to incorporating technology into language education. In addition, the universities of Salamanca and Málaga, both located in Spain, have made noteworthy contributions with 23 and 21 papers, respectively. These publications have focused on subjects such as the digital competency of instructors in early childhood education and the digital literacy of teachers after the COVID-19 pandemic.

In addition to Spain, Nanyang Technological University in Singapore and Univerza v Ljubljani in Slovenia have both published 19 papers on the topics of technological pedagogical content knowledge and qualities of digital natives, respectively. These institutes emphasise the worldwide scope of research on digital leadership in education. In addition, the Universitat de València in Spain and Universiti Malaya in Malaysia have each contributed 18 publications. The publications from the Universitat de València focus on teachers' ICT skills, while the publications from Universiti Malaya focus on the effectiveness of ICT integration in schools. To summarise, the significance of research on digital leadership in education is highlighted by the contributions of these educational institutions. Among them, Spain, Malaysia, Singapore, and Slovenia stand out as major centres of scholarly work in this topic.

The most Prolific Authors

Within the domain of digital leadership and the use of ICT by teachers, there are some authors who have made notable contributions, as demonstrated by their publication metrics. Jo Tondeur, who has an exceptional H-index of 48, has made significant progress in comprehending the acceptance of digital technologies by instructors. The author's meta-analytic methodology, presented in the publication "The technology acceptance model (TAM)" by Elsevier, thoroughly examines the underlying structural factors that impact teachers' willingness to adopt digital tools in education. Tondeur's substantial publishing record of 107 publications and over 8,692 citations highlights his significant influence in the subject.

Table (3)

Top 10 authors in the field of digital leadership and teachers' use of ICT

#	Authors	TP*	TC*	H-index	Most cited publication	Publisher
1	Tondeur, Jo	107	8,692	48	The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education	Elsevier
2	Guillén-Gámez, Francisco D.	70	751	15	Analysis of Teachers' Pedagogical Digital Competence: Identification of Factors Predicting Their Acquisition	Springer Nature
3	Yunus, M. M.	237	2,749	23	A comparison between two main academic literature collections: Web of science and scopus databases	Canadian Center of Science and Education
4	Chai, Ching Sing	259	8,704	54	Understanding pre-service teachers' computer attitudes: Applying and extending the technology acceptance model	Wiley-Blackwell
5	Tomczyk, Łukasz	94	828	17	Fear of Missing Out (FOMO) among youth in Bosnia and Herzegovina — Scale and selected mechanisms	Elsevier
6	Hatlevik, Ove Edvard	45	1,926	19	Newly qualified teachers' professional digital competence: implications for teacher education	Taylor & Francis
7	Embi, Mohamed Amin	80	826	15	Mobile learning framework for lifelong learning	

8	Jita, Thuthukile	24	95	6	A UTAUT evaluation of whatsapp as a tool for lecture delivery during the COVID-19 lockdown at a Zimbabwean University	Sciedu Press
9	Nordin, Norazah Mohd	63	551	12	Mobile learning framework for lifelong learning	
10	Palacios- Rodríguez, Antonio	45	734	15	Evaluation of teacher digital competence frameworks through expert judgement: The use of the expert competence coefficient	University of Alicante

TP= TOTAL PUBLICATIONS, TC= TOTAL CITATIONS

Ching Sing Chai has an H-index of 54, indicating the significant impact of his study. In his publication "Understanding pre-service teachers' computer attitudes" by Wiley-Blackwell, Chai provides insights into the complexities of how pre-service educators perceive digital technologies. Chai's extensive body of work, consisting of 259 articles and over 8,704 citations, has greatly enhanced our understanding of how prospective teachers interact with and interpret digital resources. As a result, his research has had a profound impact on the development of teaching methods. Ove Edvard Hatlevik stands out as a prominent character among these distinguished individuals, with a specific emphasis on the digital proficiency of recently certified educators. The publication titled "Newly qualified teachers' professional digital competence," published by Taylor & Francis, explores the consequences of digital proficiency in teacher education. Hatlevik's 45 articles and H-index of 19 highlight the urgent requirement to tackle digital competence in teacher preparation programmes in order to successfully incorporate ICT into educational practices and improve learning results. Overall, the leading authors in the realm of digital leadership and teachers' utilisation of ICT have substantial proficiency and impact, as demonstrated by their publication metrics including total publications (TP), total citations (TC), and H-index. Their research has significantly enhanced our comprehension of diverse facets pertaining to the adoption, integration, and influence of digital technology in educational environments. These writers have used careful analysis and real-world research to reveal important aspects that affect instructors' willingness to use digital tools. They have also provided insights into educators' opinions about technology and emphasised the need to develop teachers' digital skills. Moreover, their study establishes a base for future research endeavours focused on tackling growing obstacles and opportunities in utilising ICT for educational progress. The authors have provided valuable insights on mobile learning frameworks, digital competence frameworks, and the implications of ICT in teacher education. These insights can be used to inform policy-making, curriculum development, and professional development initiatives in the field of education. In summary, the combined efforts of these individuals highlight the cross-disciplinary aspect of digital leadership and the significance of promoting cooperation among educational researchers, policymakers, practitioners, and technology developers to fully utilise the potential of ICT in improving teaching and learning results.

education, highlighting the crucial role of educators in using ICT to improve learning experiences. Distance education and online education have been prominent focal points, emphasising the transition towards remote learning methods. The recurring subjects of learning systems, online systems, and information communication technology have been extensively studied to investigate the utilisation of digital systems and technologies in facilitating teaching and learning processes. In educational settings, the words educational technology, ICT infrastructures, and technological pedagogical content emphasise the connection between technology and teaching methods. In summary, the significance of these study words highlights the changing nature of digital leadership and the utilisation of ICT by teachers in education within the last ten years. To summarise, although there has been extensive research on digital leadership and teachers' use of ICT in the past decade, it is noteworthy that many themes have received less attention or have been mentioned only to a limited extent. The limited use of terms like "Digital leadership" and "Digital content" indicates a possible void in the literature on leadership methods for integrating digital technologies and developing digital educational resources. Similarly, the phrases "ICT skills" and "ICT tools" have not received much attention, suggesting a possible overlook in examining the specific abilities and resources required for successful deployment of ICT in educational environments. Furthermore, although conversations about teaching and integrating ICT imply the use of technology by teachers, there is room for more specific study that specifically examines how educators utilise digital technologies in their professional activity. To enhance scholarly discourse and optimise the benefits of ICT in education, it is important to address the areas where there is a lack of representation. This will also help in developing effective digital leadership and implementing policies accordingly.

Discussion

This bibliometric study provides a complete perspective on the changing subject of digital leadership and teachers' use of ICT. The data reveal notable trends in publication patterns between 2013 and 2023, indicating a rapid increase in research interest, notably starting in 2019. The contributions made by different nations highlight a worldwide dedication to incorporating ICT in education, with significant inputs from prominent countries and institutions. The analysis also highlights prominent authors whose extensive works have greatly influenced the discussion. The report provides a comprehensive analysis of the changing landscape in digital leadership and ICT in education by assessing important key phrases, highlighting important themes, and recommending areas where further research is needed.

The Distribution by Years

The data offers a comprehensive examination of the trends in publications pertaining to digital leadership and teachers' use of ICT from 2013 to 2023. Notably, there is a discernible upward trend in the number of publications, indicating a growing interest and research activity in this topic. The substantial increase in publications since 2019 suggests a quick pace of research, potentially driven by advancements in technology, evolving teaching approaches, and the increased recognition of the importance of digital skills in education. Furthermore, the global COVID-19 pandemic in 2020 would have significantly impacted this trend by highlighting the importance of robust digital infrastructures and effective digital leadership in educational institutions.

The most Significant Countries

An analysis of the leading countries that contribute to the discourse on digital leadership and the utilisation of ICT in education offers a comprehensive perspective on global research trends. Spain's 343 publications showcase a remarkable commitment to integrating technology and teaching methodologies, highlighting a deep understanding of leveraging digital technologies to enhance education. Malaysia prioritises the integration of ICT into educational systems to encourage pedagogical innovation. This is seen by its 127 publications on the subject. The United States, with 124 publications, demonstrates its steadfast commitment to digital leadership, using its extensive history of technological advancement and influence on global ICT educational standards. Insufficient research has been conducted on this issue at Middle Eastern educational institutions.

In addition, the fact that there are 107 publications from Indonesia and 101 publications from South Africa indicates the growing international interest in digital education. This trend exemplifies the efforts made by emerging nations to adopt technology-driven methods. India's 94 publications showcase progress in reducing the digital divide and promoting inclusive education through the utilisation of technology. The many contributions showcased in this context exemplify the wide-ranging relevance of digital leadership. They underscore the need of global collaboration in enhancing educational settings and empowering educators in the digital age.

The most Significant Educational Institutions

The report emphasises the prominent educational institutions that are making significant contributions to the research on digital leadership in teachers' utilisation of ICT from 2013 to 2023. Spanish institutions exhibit a dominant presence in the field, with Universidad de Granada leading with 36 publications, followed closely by Universidad de Sevilla with 34 publications. The former concentrates on ICT in secondary education, while the latter focuses on early childhood digital competence. Universidad de Salamanca, with 23 publications, also contributes significantly to the field by exploring early childhood digital competence. Additionally, Universidad de Málaga, with 21 publications, and Universiti Kebangsaan Malaysia has published 27 papers on the use of ICT in teaching English as a second language (ESL). Nanyang Technological University in Singapore and Univerza v Ljubljani in Slovenia both generated 19 articles each on the topics of instructional knowledge and digital natives, respectively. The Universitat de València in Spain and Universiti Malaya in Malaysia both prioritise the development of teachers' ICT competencies and their effectiveness in integrating technology into their teaching practices. These endeavours showcase a worldwide commitment to promoting digital leadership in education.

The most Prolific Authors

Several eminent authors have made significant contributions in the domain of digital leadership and the use of ICT by teachers. Jo Tondeur has an impressive academic profile, with an H-index of 48, 107 published works, and more than 8,692 citations. The author's groundbreaking study, titled "The technology acceptance model (TAM): A meta-analytic structural equation modelling approach to explaining teachers' adoption of digital technology in education," offers profound insights into the determinants that affect instructors' willingness to embrace digital technologies. Ching Sing Chai is a prominent player in the field, with an H-index of 54, 259 publications, and 8,704 citations. The research conducted by the author, which focuses on the attitudes of pre-service teachers towards digital technology, and

was published by Wiley-Blackwell, contributes to our knowledge of how to effectively adopt digital tools in education. Ove Edvard Hatlevik's research, titled "Newly qualified teachers' professional digital competence: implications for teacher education," highlights the need of developing digital proficiency in teacher training. The combined efforts of these authors, such as Francisco D. Guillén-Gámez, M. M. Yunus, and Łukasz Tomczyk, have significantly influenced the discussion on digital leadership and the use of ICT in education. Their study findings have influenced the creation of policies, the development of educational programmes, and the implementation of professional training programmes, highlighting the multidisciplinary aspect of digital leadership.

3.2. The most key terms

In recent years, there has been significant research on digital leadership in teachers' use of ICT, with particular emphasis on four important concepts. The acronym "ICT" is commonly referenced, highlighting its crucial significance in contemporary education. The term "E-learning" is also receiving considerable attention, which reflects the increasing popularity of online learning platforms. The term "education" is commonly used to indicate the wider context of integrating ICT. The term "teaching" emphasises the vital need of educators in improving instructional techniques using ICT. Furthermore, the terms "educational technology" and "digital competences" highlight the necessity of utilising digital technologies and acquiring digital abilities. The term "teachers" is used to specifically refer to their attitudes, behaviours, and requirements for professional growth. The terms "deep learning approaches" and "digital technology" indicate the use of sophisticated computer techniques. Nevertheless, the terms "Digital leadership," "Digital content," "ICT skills," and "ICT tools" are not adequately covered, indicating possible areas for further investigation in the realms of digital leadership and the integration of ICT in education.

Summary of the Results of this Review

The table (4) indicates a notable increase in research effort related to digital leadership and the integration of ICT in education. This increase has been particularly pronounced after 2019, most likely due to developments in technology and the influence of the COVID-19 pandemic. The increase in popularity of digital technologies for educational leadership and pedagogy is a result of a rising global interest in comprehending and utilising them. Spain, Malaysia, and the United States are prominent contributors, with Spanish colleges taking the lead. Authors such as Jo Tondeur and Ching Sing Chai have a significant impact on advancing research, highlighting the importance of digital skills and creative teaching methods in the field of education. The significance of terminology like ICT, e-learning, and digital competences emphasises the crucial role of technology in influencing modern educational practices, emphasising the necessity for educators to adjust and equip themselves with digital skills.

Table (4)
Summary of the results

Elements	Findings	Implications	Trends	Future Agenda
Distribution by years	Increasing number of publications from 2013 to 2023, with significant surge post-2019	Growing research interest in digital leadership and ICT in education due to advancements in technology and impacts of COVID-19	Accelerated research in recent years, particularly from 2019 onwards. Expanding international efforts and a holistic view of digital leadership.	Continued exploration of digital leadership's impact; focus on post-COVID-19 adaptations and strategies preparing for any similar event. Informing educational policies and advancing digital competencies in teaching practices
Most significant countries	Spain (343 publications), Malaysia (127), United States (124), Indonesia (107), South Africa (101), India (94)	Growing global interest and research output in digital leadership and ICT integration in education	Rising contributions from both traditional educational powerhouses and emerging economies	Encourage collaborative international research efforts; focus on digital inclusion, innovative pedagogy, and bridging the digital divide in education
Most significant educational institutions	Spain's universities leading (e.g., Universidad de Granada - 36 publications, Universidad de Sevilla - 34), significant contributions from Malaysia, Singapore, Slovenia	Spain shows a strong commitment to digital leadership in education; Malaysia and other countries also making notable contributions	Growing research activity in digital leadership and ICT integration in various global regions	Continue fostering international collaboration, focus on expanding research on practical applications of digital leadership, sustaining momentum post-COVID-19
Most prolific authors	Jo Tondeur (H-index: 48, TP: 107, TC: 8,692); Ching Sing Chai (H-index: 54, TP: 259, TC: 8,704); Ove Edvard Hatlevik (H-index: 19	-	-	-

Prominent research terms	Key terms: ICT, e-learning, education, teaching, educational technology, digital competences, teachers	Highlighting the central role of ICT in education and the need for educators to have digital competences	Growing emphasis on digital tools, online learning, and the educator's role	Address underrepresented areas such as digital leadership strategies, specific ICT skills, and digital content creation; expand focus on educators' ICT use
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In the future, it is crucial to further investigate the influence of digital leadership, particularly in post-COVID-19 situations, to provide guidance for policy-making and improve teaching methods. Global cooperation remains essential, focusing on ensuring access to digital resources and using creative teaching methods to bridge educational gaps. Future study could further explore underrepresented areas such as digital leadership methods and particular ICT abilities. Additionally, it should increase its attention on the actual use of digital tools by educators in the classroom. This collaborative endeavour will not only enhance our comprehension of the function of digital leadership in education but also expedite the creation of efficient ways to manage the ever-changing terrain of digital learning. Insufficient research has been undertaken on this subject at Middle Eastern educational institutions.

Conclusion

Ultimately, this bibliometric study provides insight into the changing field of digital leadership and the utilisation of ICT by educators in the field of education during the last ten years. The data indicates an increasing worldwide interest in using technology into educational methods, with significant contributions from various countries and educational establishments. Notable writers have greatly impacted the conversation, emphasising the need of digital skills in education. The examination of important phrases highlights crucial themes while uncovering possible avenues for future investigation and advancement. This study offers useful insights into the progress, difficulties, and possibilities in digital leadership and ICT integration, highlighting the importance of ongoing inquiry and innovation in improving educational practices in the digital era.

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