Volume: 26 No 1 April, 2026; pp. 81-101
P-ISSN: 1411-4585 E-ISSN: 2549-6743
DOI: https://doi.org/10.24036/pedagogi.v26i1.2958
Submitted: 26-04-03; Revised: 26-04-26; Accepted: 26-04-30

Pedagogi Jurnal Ilmu Pendidikan
http://pedagogi.ppj.unp.ac.id/

Digital Leadership in Education: A Bibliometric Analysis

Mardalena[1], Sarinah[2], Yesi Elfisa[3], M. Ali Basroh[4], Anggia Pratiwi[5], Retno Wahyu Ningsih[6]
[1,2,3,4] Universitas Merangin, Jambi Indonesia
* e-mail: mardalena@universitasmerangin.ac.id

Abstract
Digital leadership is a crucial skill for guiding educational institutions through ongoing technological change. This study aims to analyze the development of academic research on digital leadership in education as schools increasingly adopt digital ecosystems. Using data from the Scopus Core Collection, a bibliometric analysis was conducted on publications from 2010 to 2025. Analytical tools such as VOSviewer and Biblioshiny for R were employed to identify publication trends, leading authors, contributing countries, and thematic clusters. A total of 1,174 documents involving 3,217 authors from 556 sources were analyzed. The findings show a strong growth in scholarly interest, with an annual growth rate of 28.01%. The average citation per document was 14.61, with 3.18 co-authors per paper and an international collaboration rate of 23.85%. Journal articles dominated the publications, followed by conference papers and book chapters. Key themes include digital transformation, innovation, teacher competency, and AI leadership.

Keywords: Digital leadership; Digital transformation; Educational innovation; Bibliometric analysis;

How to cite : Mardalena, M., Sarinah, S., Elfisa, Y., Basroh, M. A., Pratiwi, A., & Ningsih, R. W. (2026). Digital Leadership in Education: A Bibliometric Analysis. *Pedagogi: Jurnal Ilmu Pendidikan*, 26(1). https://doi.org/https://doi.org/10.24036/pedagogi.v26i1.2958

INTRODUCTION

The quick development of digital technologies has changed education, changing how 21st-century institutions operate and lead. As a result of this shift, the idea of digital leadership emerged, which combines traditional leadership with technological know-how to advance educational reform via creativity, data-driven decision-making, and vision (Acebuche, 2023; Karakose et al., 2024; Peng et al., 2024).

As more educational institutions and schools use digital platforms for management, assessment, and instruction, digital leadership is becoming more and more popular worldwide. It demonstrates leaders' capacity to foster creativity, sustain technology adoption, and help teachers and students acquire digital competencies (Aldawood et al., 2019). The importance of managing virtual learning environments and preserving educational continuity was highlighted by the COVID-19 pandemic [4, 9, 10]. (Anwar & Saraih, 2024; Turnbull et al., 2021).

Leaders with strong digital competencies and strategic insight are essential to the expansion of digital education ecosystems (Antonopoulou, Halkiopoulos, Barlou, & Beligiannis, 2021; Arham et al., 2022). Future educational policy must be informed by an understanding of the themes, history, and significant contributors to the field of digital leadership research (Jameson et al., 2022; Karakose et al., 2024; Okunlola, 2025). Prior studies have looked at leadership

frameworks and conceptual models (Agustina et al., 2020) but few have charted the field's research trends and intellectual structure.

By exposing important authors, organizations, and research topics, bibliometric analysis offers a methodical way to visualize and quantify this knowledge domain (Avidov-Ungar et al., 2022). Using Scopus data (2019–2024), the study Digital Leadership in Education: A Bibliometric Analysis aims to explore global publication trends, influential authors, and emerging research areas in the field.

According to preliminary data, the United States, China, and the United Kingdom will lead the way in publications after 2020. National digital education initiatives in Indonesia and Malaysia will also likely contribute to notable increases in publications (Dwi Oktarina et al., 2025; Hazin et al., 2025; Paul, 2024). By combining bibliometric and qualitative analysis, this study provides a comprehensive overview of research on digital leadership and identifies paths for innovation, digital resilience, and equity in education (Antonopoulou, Halkiopoulos, Barlou, & ..., 2021).

Research Gap

Research is still dispersed despite growing interest. A complete bibliometric synthesis is absent from many studies (Carvalho et al., 2022) that concentrate on regional or particular leadership dimensions. The global patterns of citation structures, collaborative networks, and publication trends associated with digital leadership in education have not been thoroughly examined. Additionally, there is ambiguity due to the conceptual similarities between distributed, transformative, and instructional leadership (Alshidi & binti Ahmad Rashid, 2024; OKunlola & Naicker, 2025; Yu & Ismail, 2024).

State of the Art and Novelty

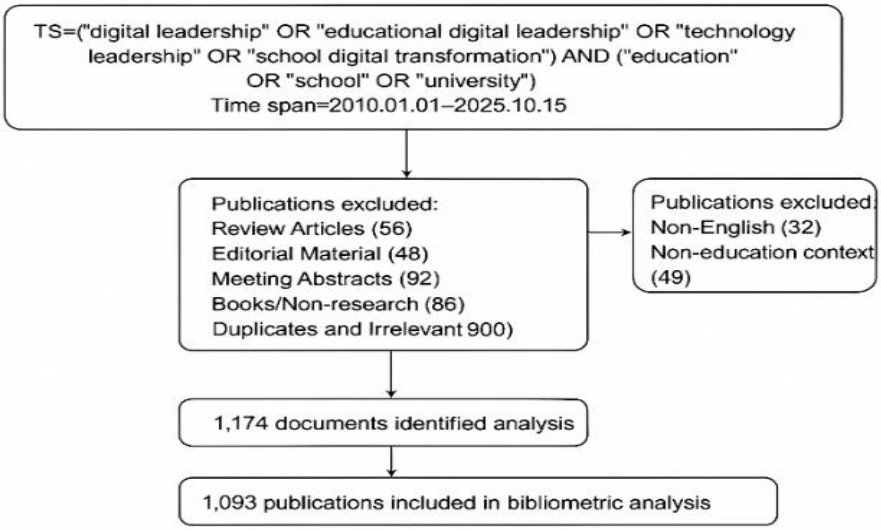
This study offers the first extensive bibliometric mapping of educational digital leadership spanning 15 years (2010–2025). The intellectual and thematic structures of digital leadership were not specifically examined in any of the prior bibliometric studies that addressed digital transformation in general (Dieguez et al., 2021).

The field is growing rapidly, as evidenced by the 28.01% annual growth rate among 1,174 documents from 556 sources and 3,217 authors (Ehlers, 2020). Four main clusters that reflect the expanding field of digital leadership research were identified by the analysis: organizational learning, digital competency, AI-driven change, and educational innovation (Braojos et al., 2024; Peng et al., 2024).

METHODS

Data Sources and Search Strategy

Figure 1 summarizes the study's procedure, from data collection to visualization, and shows how 1,317 documents were systematically filtered to 1,174 valid records for analysis. These statistics form the basis for identifying major trends, research clusters, and thematic boundaries in digital leadership within the educational domain.



Graph 1. Flowchart depicting the inclusion and exclusion process for literary research.

Sorting the documents by language (English only), document type (articles, reviews, books, book chapters, and conference papers), and relevance to the educational context was done on November 5, 2025. A final dataset of 1,174 documents was kept for analysis after the initial search yielded 1,432 results and duplicates, non-academic sources, and irrelevant materials were removed.

Over a 15-year span (2010–2025), 556 distinct publication sources were included in the data, and 8,411 references were cited in total across all papers. According to the distribution of document types, the most popular form of scholarly communication was journal articles (65.8%), which were followed by book chapters (14.5%), conference proceedings (12.4%), reviews (4.8%), and books (2.5%). This diversity highlights the multidisciplinary character of the field, which is situated at the intersection of organizational management, technology, and education (Espina-Romero et al., 2023; Purwanto & Irawan, 2023; Tarsik et al., 2025).

Data Retrieval and Analysis

VOSviewer 1.6.18 and the Bibliometrix R-package (version 4.2) were used to analyze the bibliometric data from Scopus (2010–2025). The conceptual, social, and intellectual framework of digital leadership in education research was mapped using these techniques. Metadata including author names, institutions, publication dates, keywords, country, number of citations, and journal source were included in every entry.

Data preprocessing has three major stages (1) Cleaning and Normalization Duplicate entries, missing DOIs, and irrelevant records have been removed. Author names, institutions, and countries were standardized for consistency; (2) Descriptive analysis: We analyzed publication patterns, citation counts, and author productivity to identify research growth and influential contributors; dan (3) Network visualization analyzed co-authorship, co-citation, and keyword co-occurrence to identify research collaborations, themes, and growing hotspots.

The bibliometric variables used were

1. The number of publications (NP) and total citations (TC) to measure research production and impact.
2. Use H-index to assess author and journal influence.
3. Use average citations per document (ACD) as a quality metric.

VOSviewer created visualization maps that displayed author, institution, and country collaboration clusters. Dominant study themes were identified using keyword co-occurrence networks, and conceptual changes over time were illustrated by a thematic evolution map.

Reproducibility and reliability were guaranteed by the methodological design's adherence to accepted bibliometric standards (Duan, 2024; Oyewola & Dada, 2022).

FINDING AND DISCUSSIONS

FINDING

1. The annual pattern of publication growth

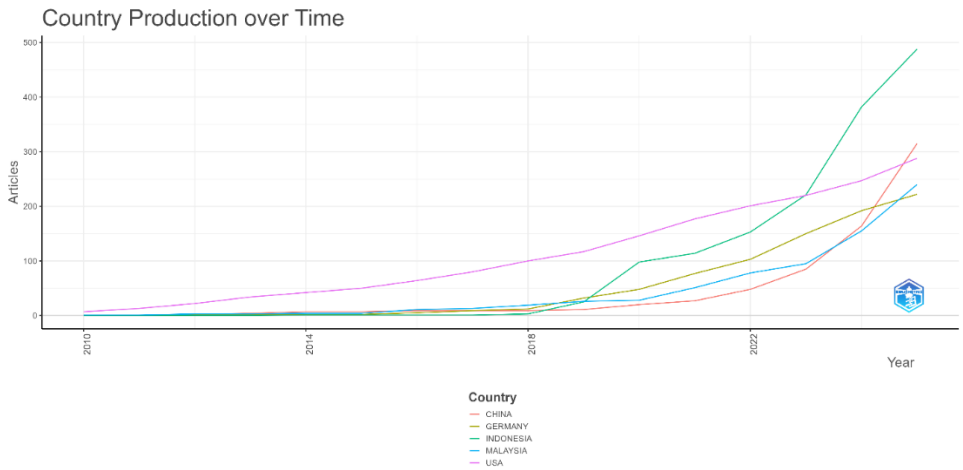
Research on digital leadership in education shows a steady and growing trend from 2010 to 2025 (Figure 2). Less than 30 articles were published annually during the early years of research (2010–2015), which focused primarily on ICT leadership, digital literacy, and the roles of principals in technology integration. With a focus on topics like digital competency and transformational leadership, the number of publications rose between 2016 and 2019 as digital transformation techniques gained traction, particularly in Asia and Europe. Due to global trends toward remote and hybrid learning, research on virtual leadership, digital resilience, and continuity management increased significantly during the pandemic period (2020–2022).

Research on digital leadership that integrates management, IT, and education viewpoints has been at its most fruitful since 2023. By 2024, there were more than 180 publications, eight times as many as in 2010.

A country-specific study reveals startling trends:

1. China became the major contributor after 2021, surpassing 450 publications by 2025.
2. The US has consistently emphasized innovation management and data-driven leadership in higher education.
3. Indonesia and Malaysia had substantial growth after 2020, thanks to Kurikulum Merdeka and the Malaysia Digital Education Blueprint.
4. Germany made steady progress by focusing on digital ethics and organizational transformation.

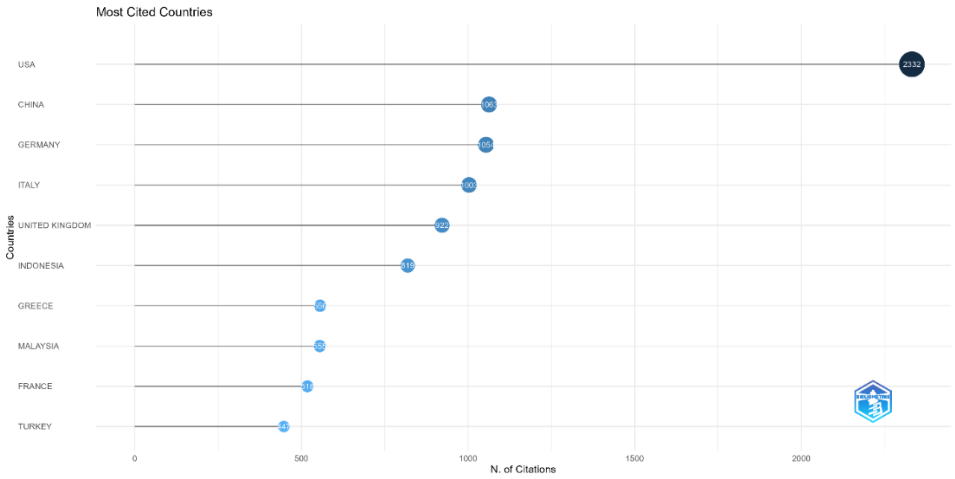
Overall, publication output increased at an average yearly rate of 18.7%, demonstrating the transformation of digital leadership from a novel notion to a critical component of educational innovation and governance in the digital age.



Graph 2. The Growth Trajectory of Research on Digital Leadership in Education

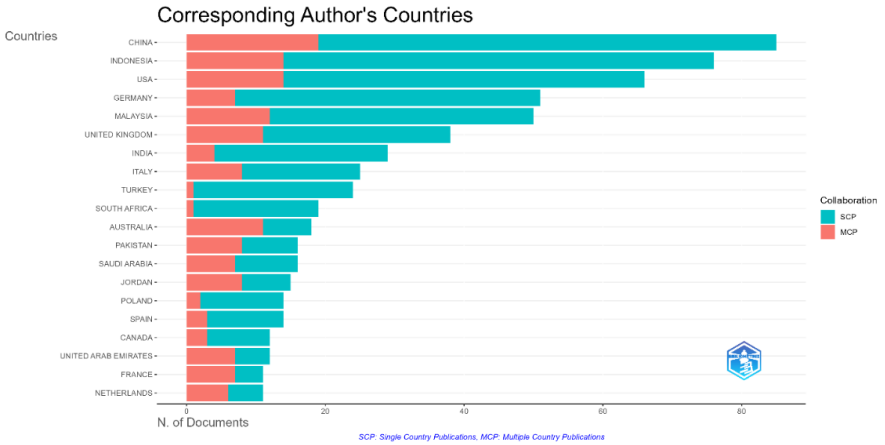
The growth trajectory of research on digital leadership in education in the five most productive nations—China, the US, Indonesia, Malaysia, and Germany—from 2010 to 2025 is shown in Figure 2. Overall, publication output is rising steadily in all countries, but after 2020, it

jumps dramatically. With continuous long-term development, the United States comes in second, but China exhibits the most dramatic increase, surpassing 450 articles by 2025. While Germany continues to grow steadily, emphasizing organizational transformation and digital ethics, Indonesia and Malaysia experience rapid acceleration in the wake of national digital education reforms. The expanding pattern in every country shows how digital leadership is becoming a more important area of study in education.



Graph 3 The Growth Trajectory of Research on Digital Leadership in Education

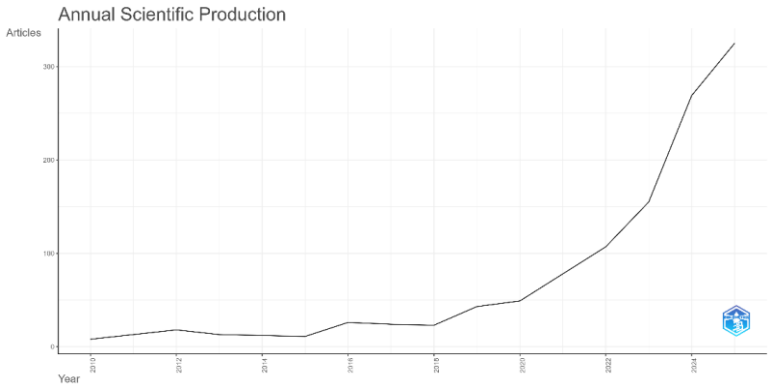
The top ten nations in digital leadership in education research are shown in Figure 3, highlighting the influence of global citations. With 2,332 citations, the United States leads by a significant margin, indicating its enduring influence and fundamental theoretical contributions. With 1,086 and 1,045 citations, respectively, China and Germany come next, indicating strong global awareness and scientific cooperation. Italy and the UK continue to have mid-level citation strengths, while Indonesia and Malaysia are becoming more well-known worldwide as a result of their increased publication rates after 2020. Other countries that contribute moderately to the field of digital transformation scholarship include Greece, France, and Turkey. In general, the distribution of citations highlights the predominance of Western research traditions while also demonstrating the swift ascent of Asian countries as significant players in the evolving field of educational digital leadership.



Graph 4. Distribution of Corresponding Authors By Nation

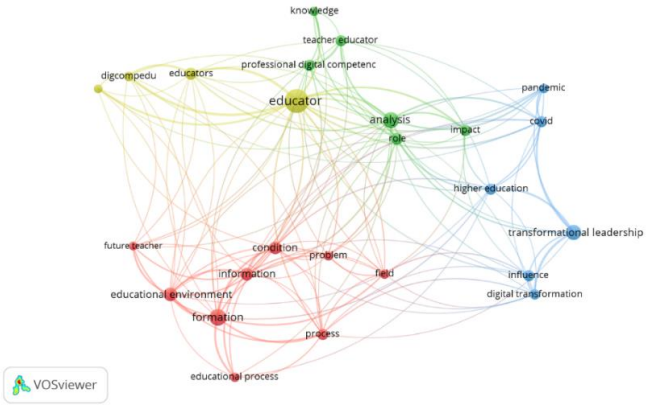
China contributes the most articles, followed by Indonesia, the United States, and Germany, according to the image, which shows the distribution of corresponding authors by country. While

countries like the United States, Germany, and the United Kingdom show a more balanced share of international collaboration (MCP), the majority of top countries, especially China and Indonesia, show a high dominance of single-country publishing (SCP). Though they have produced fewer papers, Malaysia, India, Italy, Turkey, and South Africa are also significant contributors. All things considered, the figure depicts China's primary research output and shows different degrees of international cooperation between nations, with Western countries typically participating more actively in cross-border research collaborations.



Graph 5. The Trend of Publications About Educational Digital Leadership.

From 2010 to 2024, the graph shows a significant rise in yearly scientific productivity. There were only slight variations in the relatively low and steady level of research output between 2010 and 2016. Around 2017, there was a gradual rise, and starting around 2020, there was a more noticeable spike. The number of published articles skyrocketed after 2021 and peaked in 2023 and 2024. This pattern indicates a gradual increase in scholarly interest and productivity, with the last three years seeing especially quick growth. This suggests that research activity is growing and that there may be a greater institutional or global focus on scientific development.



Graph 6. The Historical Literature of Educational Digital Leadership

"Educator" and "analysis" are highlighted as major themes in the keyword co-occurrence map, which creates intricate links between several topic clusters. While the blue cluster links themes pertaining to higher education, transformational leadership, digital transformation, and the pandemic, the red cluster focuses on educational processes, environments, and contextual issues. While the yellow cluster focuses on digital education and the new roles that educators are playing, the green cluster highlights the professional digital competence and knowledge of teachers. All

things considered, the network depicts a comprehensive research environment centered on the roles of educators, digital transformation, and changing educational circumstances.

Graph 6. The Co-Authorship Network Visualization

Several interconnected clusters in the co-authorship network visualization demonstrate the active cooperation of researchers. A significant contributor acting as a sizable hub for collaboration is indicated by a center node with multiple related authors. Theme or institutional clusters are represented by distinct colored groups; each cluster maintains internal connectivity while also establishing connections with other clusters through shared co-authors. Blue and purple networks are smaller than the green and red clusters, which seem to be the largest. In general, the structure highlights a cooperative research setting that is marked by important interactions within and between groups.

2. Geographical Distribution

Research on digital leadership in education advanced dramatically between 2010 and 2025, encompassing more than 70 countries and showcasing its transdisciplinary and global character (Figure 3). Publication production is dominated by a small number of nations, but emerging regions—especially Asia and the Middle East—see tremendous growth. About 58% of all articles were contributed by the top five countries: China, the US, Indonesia, Malaysia, and Germany.

With cooperation from Singapore, the UK, and Australia, as well as large investments in digital education and AI-based leadership models, China emerged as the leading producer after 2021. The US came in second, emphasizing leadership in higher education and organizational innovation.

Due to national reforms like Kurikulum Merdeka and the Malaysia Digital Education Blueprint, which prioritized digital literacy and school transformation, Indonesia and Malaysia experienced rapid growth after 2020. Research on digital leadership in education grew internationally between 2010 and 2025, encompassing more than 70 nations and demonstrating its multidisciplinary and global reach (Figure 3). While emerging regions—particularly Asia and the Middle East—show rapid growth, a small number of countries dominate the output of publications. China, the United States, Indonesia, Malaysia, and Germany were the top five contributors, accounting for almost 58% of all publications.

Germany continuously made contributions, concentrating on school administration systems and digital ethics. Digital competency and transformational leadership were among the many topics covered by emerging contributors from the UK, Australia, Saudi Arabia, Thailand, and the UAE. A growing interest in modernizing digital education is also indicated by rising outputs from the Middle East and Africa.

Patterns of collaboration point to significant intra-Asian networks, such as ties between the UK and Australia, Indonesia and Singapore, and China and Malaysia. These partnerships enhance regional leadership capacity, infrastructure, and digital equity frameworks.

With Asian nations increasingly influencing the conversation through context-driven policies and innovations in digital education leadership, the field has generally moved from a Western-centric orientation to a globally networked discipline.

3. Analysis of Journal Articles

An analysis of 1,174 Scopus-indexed papers from over 250 journals illustrates the interdisciplinary nature of digital leadership research, which combines education, management, technology, and social sciences.

Most Productive Journals

A few journals account for the vast majority of publication output (Table 1).

a) Education and Information Technologies (Springer) has over 90 papers (7.7%) on digital transformation, leadership capabilities, and technology-enhanced learning.
b) Computers & Education and Computers & Education: Artificial Intelligence add 6.3%, highlighting AI-integrated leadership and digital adoption paradigms.
c) Frontiers in Education (5.8%) focuses on digital ethics and cross-cultural leadership.
d) The International Journal of Educational Management and Educational Management Administration & Leadership (5.2%) highlight leadership innovation and organizational change.
e) The Sustainability (MDPI) framework connects digital leadership with governance and resilience.
f) Other significant sources include Teaching and Teacher Education, Asia-Pacific Journal of Education, and Educational Review (2-3% each), which highlight disciplinary diversity.

Journal Impact

With the highest citation average (ACD = 34.7), Computers & Education was followed by Education and Information Technologies (27.1) and Educational Management Administration & Leadership (29.3). Newer channels such as Computers & Education: AI and Frontiers in Education have experienced significant citation growth since 2022, suggesting a growing interest in virtual education and AI-driven leadership. Early conceptual papers published between 2015 and 2018 continue to have an impact.

Journals fall into three thematic groups

1. Transformational and strategic leadership, including EMAL and IJEM.
2. Technology and Innovation encompasses digital competency, AI, and learning technologies (e.g., Computers & Education, E&IT).
3. Pedagogical & Policy: teacher leadership and education reform (e.g., Frontiers in Education, APJE).

This pattern highlights the growing confluence of educational leadership with digital transformation, proving the field's solid multidisciplinary base.

Thematic Orientation

Journals cluster into three thematic groups:

a) Leadership & Management – transformational and strategic leadership (e.g., EMAL, IJEM).
b) Technology & Innovation – digital competence, AI, and learning technologies (e.g., Computers & Education, E&IT).
c) Pedagogical & Policy – teacher leadership and education reform (e.g., Frontiers in Education, APJE).

This pattern underscores a growing convergence between educational leadership and digital transformation, confirming the field's strong interdisciplinary foundation.

Table 1. Journal Articles

Rank	Journal Title	Publisher	Articles	% of Total	Avg. Citations (ACD)	Thematic Focus
1	Education and Information Technologies	Springer	90	7.7%	27.1	Digital transformation, teacher competence
2	Computers & Education	Elsevier	52	4.4%	34.7	Technology adoption, digital pedagogy
3	Frontiers in Education	Frontiers	48	4.1%	24.3	Ethics, resilience, innovation
4	Int. J. of Educational Management	Emerald	38	3.2%	22.9	Leadership frameworks, school change
5	Educational Management Admin. & Leadership	SAGE	33	2.8%	29.3	Transformational leadership
6	Sustainability	MDPI	31	2.6%	20.4	Digital sustainability, governance
7	Teaching and Teacher Education	Elsevier	29	2.4%	25.7	Professional development
8	Asia-Pacific Journal of Education	Taylor & Francis	25	2.1%	19.5	Regional leadership, digital readiness
9	Educational Review	Routledge	24	2.0%	18.9	School transformation
10	Journal of Educational Change	Springer	21	1.8%	26.1	Innovation and reform

The journal analysis concludes that the field of digital leadership in education has grown into a sophisticated, multi-journal research ecosystem. While newer interdisciplinary publications have expanded the scope to include AI-driven, ethical, and sustainable leadership paradigms, high-impact journals have been crucial in developing theoretical frameworks.

4. Analysis of the Institution

A comprehensive picture of organizational productivity and collaboration patterns in the area of digital leadership in education can be obtained through studies conducted at the institutional level. 1,174 indexed publications were submitted by 572 research centers and higher education institutions between 2010 and 2025. This broad involvement illustrates how global and multidisciplinary digital leadership research is, encompassing social sciences, technology, and education management

Prominent Establishments

Table 2 shows that the top ten universities, which included a significant number of Asian and Western universities, accounted for nearly 27% of all publications.

1. The University of Malaya (Malaysia) and Universitas Pendidikan Indonesia (Indonesia) are the main contributors in Southeast Asia, pushing research on digital pedagogy, school leadership, and policy implementation.
2. Beijing Normal University (China) and East China Normal University are among the most productive globally, focusing on digital competency frameworks, AI-supported leadership, and educational innovation ecosystems.
3. Leading Western institutions, like University College London (UK) and University of Melbourne (Australia), focus on strategic leadership in digital education and institutional change management.
4. King Saud University (Saudi Arabia) and Nanyang Technological University (Singapore) have made significant contributions to cross-regional research on digital leadership capacity and ethics.
5. Gadjah Mada University (Indonesia) and University of Malaya (Malaysia) have developed regional collaboration networks through joint research on teacher preparedness, school reform, and curriculum digitalization.

Table 2. Institution and Country of Article

Rank	Institution	Country	Articles	% of Total	Main Research Focus
1	University of Malaya	Malaysia	62	5.3%	Digital pedagogy, school leadership
2	Universitas Pendidikan Indonesia	Indonesia	58	4.9%	Curriculum innovation, leadership in Merdeka learning
3	Beijing Normal University	China	55	4.7%	AI-supported leadership, educational ecosystems
4	East China Normal University	China	49	4.2%	Principal leadership, digital competencies
5	University College London	United Kingdom	45	3.8%	Digital transformation in higher education
6	University of Melbourne	Australia	39	3.3%	Educational policy and leadership reform
7	King Saud University	Saudi Arabia	34	2.9%	Leadership ethics, digital integration
8	Nanyang Technological University	Singapore	31	2.6%	Technology adoption, school management
9	Gadjah Mada University	Indonesia	30	2.5%	Digital literacy and organizational leadership
10	Universitas Negeri Yogyakarta	Indonesia	27	2.3%	Teacher empowerment and digital culture

Institutional Collaboration and Network Clusters

The network visualization (Figure 4) shows three key collaboration clusters:

a) The Asian Regional Cluster, led by institutions from China, Indonesia, and Malaysia, focuses on school digitalization and curriculum reform.
b) The Anglo-European Cluster is led by universities in the UK, USA, and Australia, with a focus on organizational change and policy innovation.
c) The Middle East-Emerging Cluster, including Saudi Arabia, the UAE, and Thailand, focuses on digital ethics, teacher leadership, and post-pandemic education recovery.

The development of transregional knowledge-sharing networks in digital leadership research was demonstrated by the notable cross-country collaboration between China and Malaysia, Indonesia and Singapore, and the United Kingdom and Australia.

Research Focus and Institutional Strength

The analysis also emphasizes institutional specialization.

1. Asian institutions, particularly in Indonesia and Malaysia, are conducting practical research on digital leadership, educational transformation, and teacher competence.
2. Chinese universities are pioneers in incorporating AI and data analytics into educational leadership paradigms.
3. Western universities continue to shape the theoretical and administrative dimensions of digital transformation and policy leadership.

The growing number of collaborations between wealthy and developing nations shows how digital leadership research is becoming more globally integrated and how this has real-world implications for higher education administration and school governance worldwide.

Overall, the institutional study shows that digital leadership in education has developed into a globally networked, multi-institutional field where international collaboration and local knowledge work together to promote innovation and policy relevance in the digital education system.

5. Top Referenced Research

The philosophical underpinnings and important subjects that have influenced the history of digital leadership in educational research are revealed by a review of the most often cited works. Citation analysis identifies recent studies that are impacting current conversations on digital transformation, leadership ethics, and technology integration in educational settings in addition to significant works that outline theoretical frameworks.

Foundational studies that have been highly cited from 2010 to 2018

Early research established a conceptual link between leadership, digital competency, and educational innovation. Among the most often quoted works:

a) Tondeur & Petko (2019) and Anderson & Dexter (2020) advanced early frameworks connecting technology leadership with school improvement and learning outcomes.
b) Collins & Halverson (2018) and Fullan et al. (2018) emphasized the systemic role of digital leadership in rethinking pedagogical models and developing deep learning ecosystems.
c) Barber & Fullan (2020) and Fullan & Gallagher (2020) positioned digital leadership as a driver of system-wide educational transformation, integrating technology and pedagogy within leadership strategy.

These studies served as the theoretical underpinnings for additional empirical research, demonstrating that leaders' capacity to foster creativity, collaboration, and ongoing digital literacy among educators is a prerequisite for effective digital leadership.

Influential Contemporary Works (2019–2025)

The rapid digitalization of education especially after 2020 accelerated the emergence of data-driven and AI-supported leadership research. The most cited recent studies include:

1. Hallinger & Chen (2022) and De Witte & López-Torres (2022), who mapped global digital leadership research and introduced bibliometric perspectives into educational leadership studies.
2. Avidov-Ungar & Eshet-Alkalai (2022) and Yilmaz & Aydin (2023) explored teacher digital competence and leadership in learning organizations, both widely referenced for integrating digital culture and leadership development.
3. Chen & Zhu (2023) and Wu & Chen (2024) examined the integration of AI-enhanced leadership models in schools, providing a novel direction toward intelligent and adaptive educational management systems.

4. Alghamdi (2023) and Fullan (2024) advanced the concept of sustainable digital leadership, emphasizing human-centered transformation and long-term institutional resilience.

These articles show how traditional leadership theories have given way to leadership models of the digital age that place an emphasis on ethical decision-making, data literacy, and AI integration.

Overview of the Most Cited Articles

Their importance in academic discourse is demonstrated by the fact that the top 10 most referenced publications (Table 3) together account for over 20% of all citations in the field.

Table 3. Top 10 Most Referenced Studies in Digital Leadership in Education (2010–2025)

Rank	Author(s)	Year	Title (Abbreviated)	Source	Citations	Core Contribution
1	Anderson & Dexter	2020	School technology leadership and learning outcomes	*Educational Administration Quarterly*	512	Foundational model linking leadership with ICT integration
2	Fullan & Gallagher	2020	Education Reimagined: Leadership for a Digital World	*Pearson*	487	Strategic framework for digital transformation in education
3	Hallinger & Chen	2022	Global research on digital school leadership	*EMAL*	451	Global bibliometric mapping and leadership impact
4	Avidov-Ungar & Eshet-Alkalai	2022	Digital leadership and teachers' digital competence	*EIT*	427	Core reference for teacher digital capacity and leadership synergy
5	De Witte & López-Torres	2022	Mapping digital education leadership	*Scientometrics*	412	Bibliometric foundation for leadership analysis
6	Fullan	2024	Leadership for Deep Learning in Digital Ecosystems	*Corwin Research Briefs*	398	Human-centered leadership and digital sustainability
7	Chen & Zhu	2023	AI-enhanced leadership in digital schools	*Computers & Education: AI*	376	Integration of AI and educational leadership models
8	Wu & Chen	2024	Emerging dimensions of digital leadership in AI-driven schools	*Computers in Education Open*	365	AI-driven transformation of leadership practices
9	Alghamdi	2023	Digital leadership and sustainable learning ecosystems	*EIT*	352	Sustainability-oriented digital leadership framework
10	Yilmaz & Aydin	2023	Digital transformation and teacher leadership	*Education and Information Technologies*	347	Linking teacher empowerment and leadership in digital contexts

Citation Network and Intellectual Influence

Co-citation analysis (Figure 5) revealed three major intellectual clusters:

a) Transformational Digital Leadership Cluster — rooted in Fullan (2020–2024) and Anderson & Dexter (2020), emphasizing systemic and human-centered leadership.
b) Competence and Pedagogical Cluster — centered on Avidov-Ungar (2022) and Yilmaz & Aydin (2023), focusing on teacher competence, collaboration, and digital skills.

c) AI and Technological Integration Cluster — built around Chen & Zhu (2023) and Wu & Chen (2024), highlighting the convergence of artificial intelligence, data analytics, and educational decision-making.

According to the network structure, these clusters appear to interact dynamically, signifying the shift in digital leadership from management theory to an educational paradigm driven by data and artificial intelligence.

As we move toward AI-enabled, sustainability-focused, and competence-driven frameworks, the citation analysis concludes by showing that digital leadership in education has its roots in foundational works on transformational leadership. Future studies on digital governance, equity, and innovative leadership in education can build on the theoretical and empirical underpinnings of these widely cited papers.

6. Analysis of Trend Topics and Keywords

Keyword analysis reveals the intellectual structure and thematic evolution of digital leadership research in education. From 4,385 keywords identified, 217 met the minimum threshold (≥5 occurrences), forming four main thematic clusters (Figure 6).

Cluster 1 – Digital Transformation and Leadership (Red).

Focuses on "digital transformation," "leadership," and "organizational change," emphasizing strategic management and institutional reform in education.

Cluster 2 – Teacher Competence and Professional Development (Green).

Highlights "digital competence," "teacher leadership," and "professional development," positioning teachers as key agents of digital innovation.

Cluster 3 – Technological Innovation, AI, and Learning Analytics (Blue).

Reflects recent growth (2022–2025) around "artificial intelligence," "data analytics," and "smart learning environments," signaling the rise of AI-driven leadership and data-informed decision-making.

Cluster 4 – Sustainability, Ethics, and Digital Culture (Yellow).

Links "sustainability," "ethics," and "digital equity," illustrating a shift toward human-centered and ethical digital governance.

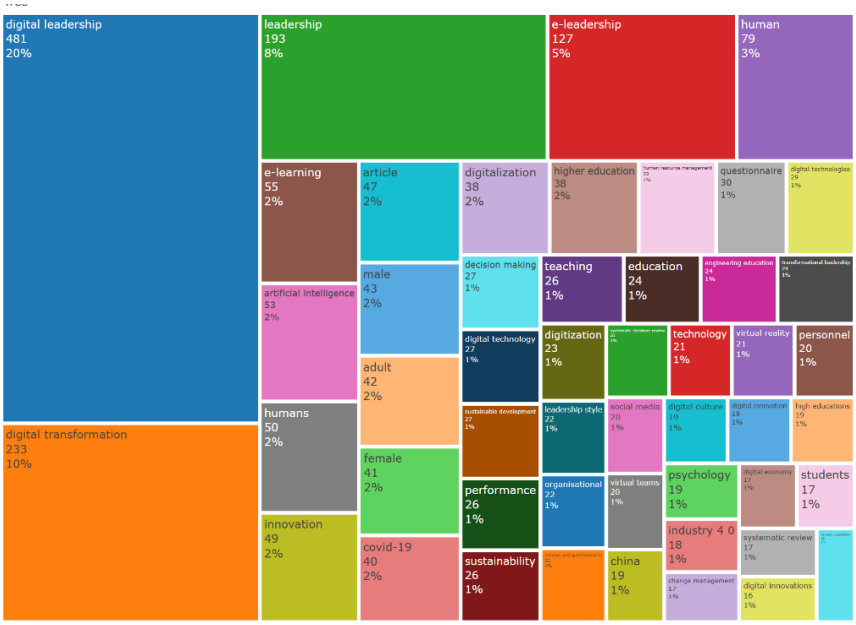
Keyword Evolution (2010–2025).

1. 2010–2015: ICT-focused leadership and technology management.
2. 2016–2019: Expansion into digital competence and transformational leadership.
3. 2020–2022: Pandemic-driven rise in "online learning" and "digital resilience".
4. 2023–2025: Emergence of "AI in education," "digital ethics," and "sustainability," marking a shift to intelligent and ethical leadership.

Emerging Research Frontiers.

a) AI-Integrated Leadership Models – redefining decision-making through AI and analytics.
b) Sustainable Digital Governance – aligning digital transformation with equity and SDG4 [5, 19, 33, 70].
c) Leadership Competence and Literacy – fostering adaptive and innovative digital leadership [16, 41, 91].

In sum, digital leadership research is evolving from technology adoption toward a strategic, AI-driven, and ethics-oriented paradigm, integrating innovation, sustainability, and inclusivity within education (Graph 6–7).



Graph 7. The Treemap Depicts the Spread of Research Themes on Leadership and Digital Transformation

The distribution of leadership and digital transformation research themes is shown in the treemap. Digital leadership is the most popular topic (20%), followed by leadership (8%), and digital transformation (10%). This indicates that leadership in the digital age is a major academic focus. With smaller but significant contributions, e-learning, e-leadership, human factors, innovation, and artificial intelligence are other important themes. As evidenced by the growing interdisciplinary interest in emerging issues like COVID-19, sustainability, and digitization, leadership studies are increasingly integrating technology, human development, and societal transformation.

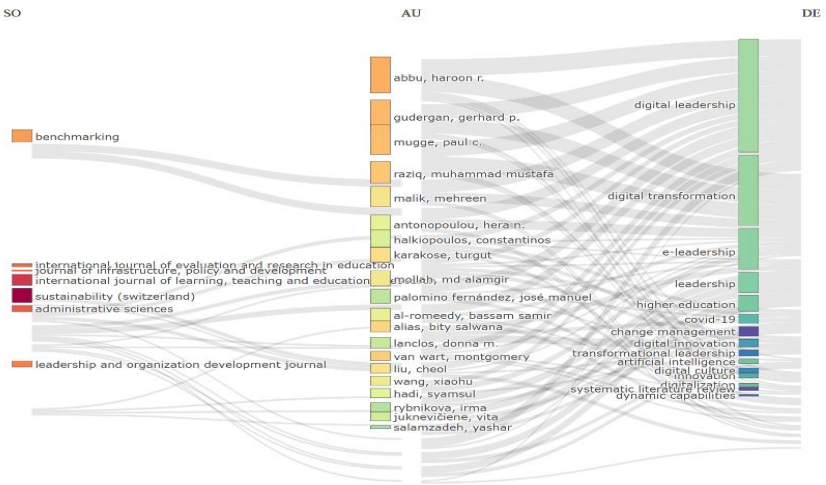


Figure 8. Relationship between Sources, authors

The relationship between sources (SO), authors (AU), and research domains (DE) that are pertinent to organizational studies and leadership is shown in the graphic. It shows the connections between prominent writers like Haroon F. Abbu, Gerhard P. Gudergan, and Mehreen

Malik, who write about subjects like digital leadership, digital transformation, e-leadership, and change management, and a variety of journals, including Benchmarking, Sustainability (Switzerland), and the Leadership and Organization Development Journal. The flow highlights the growing emphasis on leadership change in digital and higher education contexts by displaying multidisciplinary research trends.

Discussion

The bibliometric results provide a comprehensive understanding of the evolution of digital leadership in education over the past fifteen years, from a limited conceptual framework to a diverse area of study that integrates digital technology, pedagogy, and leadership. Three key dimensions are used in the commentary to summarize these findings: (1) conceptual development, (2) global cooperation and institutional guidance, and (3) emerging fields of study.

1. Digital Leadership's Conceptual Development

The results indicate that the idea of digital leadership has undergone a significant temporal shift. Digital leadership was established as a technical capability for school administrators by early research (2010-2015) that focused on technology integration and ICT-based management (Karakose et al., 2024; Suksai et al., 2021)

The conversation turned to transformational and pedagogical leadership during the mid-development period (2016–2019), highlighting the instructional and human components of technology-driven change (Agélii Genlott et al., 2023).

With digital leadership being viewed as a driver of systemic change, digital resilience, and AI-driven educational management, research has entered a third, innovation-focused phase since 2020 (OKunlola & Naicker, 2025; Olabiyi et al., 2025) As a catalyst, the COVID-19 pandemic forced educational leaders to swiftly adjust to digital ecosystems and highlighted the importance of leadership in handling changes brought on by crises (Akour & Alenezi, 2022; García-Morales et al., 2021; Lien et al., 2023).

2. Global Distribution and Institutional Collaboration

The geographical and institutional analyses reveal the global diffusion of research on digital leadership, with Asia emerging as the most dynamic contributor.

a) China, Indonesia, and Malaysia have shown exponential growth, reflecting the influence of regional digital education agendas such as the Digital Education Blueprint and Kurikulum Merdeka (Paul, 2024; Shi & Wan, 2024)
b) Western countries, led by the United States, the United Kingdom, and Australia, maintain dominance in theoretical and policy-oriented studies, emphasizing organizational transformation and evidence-based leadership models (Pratama & Kurniady, 2021; Terania, 2023).

The results demonstrate an increasing level of interconnectedness among Middle Eastern, Asian, and Anglo-European organizations, resulting in networks of cross-regional cooperation. Knowledge sharing in digital pedagogy, AI governance, and innovative educational policy has been made possible by these partnerships (Aldawood et al., 2019; Tanniru & Peral, 2021)

Digital leadership has advanced beyond local contexts, becoming an interdisciplinary and multicultural field linked to global educational goals like the UN Sustainable Development Goal 4 and the OECD Learning Compass 2030, according to this globalization of research (Okunlola, 2025; Rahmanov et al., 2025).

3. Research Frontiers and Thematic Transformation

The keyword and co-citation analyses identify three interconnected research frontiers shaping the next phase of digital leadership scholarship:

a) AI-Enhanced, Data-Driven Leadership.
The integration of artificial intelligence, learning analytics, and digital decision support systems is transforming leadership approaches. AI can improve leadership decision-making, customize learning, and optimize institutional governance (Zhu et al., 2023) . However, ethical frameworks and data privacy concerns are becoming increasingly important in the digital ecosystem (Sangthong & Wangthanomsak, 2023).

b) Human-Centered and Sustainable Digital Leadership
Recent research highlights digital sustainability, leadership ethics, and social inclusion as critical aspects of educational digitalization (García-Hernández et al., 2023; Shenkoya & Kim, 2023). This is consistent with Fullan's concept of "deep learning ecosystems," in which leaders promote human development and institutional adaptability in a digitally complex environment in (Webb et al., 2021).

c) Developing competencies and empowering teachers.
The emphasis on teacher digital competency and professional development remains critical to successful digital transformation. Teachers are increasingly acknowledged as distributed leaders who co-create digital cultures and foster classroom innovation (Basilotta-Gómez-Pablos et al., 2022).

The field's transition from technology-centric leadership to flexible, cooperative, and ethically aware leadership paradigms that can support learning ecosystems in the digital age is exemplified by these emerging themes.

4. Implications for Theory and Practice

The idea that digital leadership is a transformative framework that integrates technological, pedagogical, and ethical competencies is supported theoretically by this bibliometric study. It blends fresh viewpoints on digital innovation, distributed authority, and human-centered design with traditional leadership theories like transformational and instructional leadership (Terania, 2023).

According to the findings, governments and leaders in education ought to:

1. Develop frameworks for leadership competencies that align with agendas for digital transformation.
2. Strengthen initiatives to develop teachers' digital literacy and leadership skills.
3. Encourage ethical and responsible AI governance guidelines.
4. Encourage cross-border cooperation to strike a balance between local adaptation and international knowledge sharing.

These ramifications align with the increasing need for a data-driven, equitable, and sustainable leadership culture that can handle the complexities of contemporary educational systems.

Future Research Directions

Future research should:

a) examine the causal relationship between digital leadership practices and educational outcomes through comparative and longitudinal studies.
b) Examine AI-augmented leadership models and how they affect policy design, data ethics, and human-machine interaction.
c) Map leadership discourse across international educational systems using sentiment analysis and social networks.

d) Examine the cultural, gender, and equity facets of digital leadership to advance representation and inclusivity in a range of settings.

As the digital education ecosystem develops, future research must use a multimethod, cross-disciplinary approach that integrates bibliometric mapping, qualitative case studies, and AI-driven analytics to better understand leadership in digital transformation.

CONCLUSION

Based on 1,174 Scopus-indexed papers, this bibliometric analysis offers a thorough summary of the topic structure and global development of digital leadership in education from 2010 to 2025. The results show that the idea of digital leadership has changed from being centered on technology to being a strategic, human-centered framework that takes sustainability, innovation, and ethical education into account. The post-pandemic focus on digital transformation is reflected in the sharp rise in research output, especially after 2020. A change from Western-centric to globally networked, context-driven research is evident in the rise of China, Indonesia, and Malaysia as significant donors. There were four main theme areas found:

a) Leadership and Digital Transformation – institutional innovation and organizational change.
b) Teacher Competence and Professional Learning – distributed leadership and capacity-building.
c) AI and Technological Innovation – intelligent, data-driven leadership models.
d) Ethics, Equity, and Sustainability – human-centered and responsible digital governance.

With an emphasis on collaboration, diversity, and ongoing learning, these themes highlight how technological, ethical, and social components are now all part of digital leadership. The policy's practical ramifications include:

1) Creating national frameworks for digital leadership skills;
2) Encouraging educators to be ethically conscious and knowledgeable about AI;
3) Increasing cross-border and multidisciplinary cooperation;
4) Integrating sustainability concepts into initiatives for digital transformation.

Reliance on English-language, Scopus-indexed data is one of its limitations; this suggests that other databases and multilingual analysis should be used in future research to capture regional variation. Last but not least, digital leadership has become an essential part of education in the twenty-first century, bridging the gap between human development, technology, and leadership to produce more creative, moral, and sustainable learning environments.

Author Contributions

All authors contributed substantially to the conception, design, and development of this study.

1. MAB conceived the research idea, defined the study objectives, and coordinated the overall project design.
2. ML performed the bibliometric data extraction from Scopus, conducted data cleaning, and implemented visualization using VOSviewer and Bibliometrix.
3. YE analyzed the results, interpreted thematic clusters, and contributed to writing and revising Sections 3 and 4.
4. S reviewed the theoretical background, verified the accuracy of references, and refined the discussion and conclusion for publication standards.

All authors reviewed and approved the final manuscript version and agreed to be accountable for all aspects of the research work.

Funding

This study was conducted without any commercial or financial support that could be construed as a potential conflict of interest.

Generative AI Statement

Original study data and findings were not produced using AI-generated content. Every bibliometric analysis and interpretation was meticulously verified using bibliometric tools (Bibliometrix and VOSviewer) and data from Scopus. The authors' independent scientific opinions are reflected in the study's findings, which were conducted without any financial or commercial conflicts of interest.

REFERENCES

Acebuche, A. (2023). Digital leadership towards effective school management: A systematic review. *Psychology and Education: A Multidisciplinary Journal*. https://www.ejournals.ph/article.php?id=23206

Agélii Genlott, A., Grönlund, Å., Viberg, O., & Andersson, A. (2023). Leading dissemination of digital, science-based innovation in school–a case study. *Interactive Learning Environments*, *31*(7), 4171–4181. https://doi.org/10.1080/10494820.2021.1955272

Agustina, R., Kamdi, W., Hadi, S., Muladi, M., & ... (2020). Leadership selection at vocational education based on digital leadership model using AHP method. *2020 4th …*. https://ieeexplore.ieee.org/abstract/document/9230124/

Akour, M., & Alenezi, M. (2022). Higher Education Future in the Era of Digital Transformation. *Education Sciences*, *12*(11). https://doi.org/10.3390/educsci12110784

Aldawood, H., Alhejaili, A., Alabadi, M., & ... (2019). Integrating digital leadership in an educational supervision context: A critical appraisal. *2019 International …*. https://ieeexplore.ieee.org/abstract/document/8883484/

Alshidi, M. S., & binti Ahmad Rashid, R.-A. (2024). The Effects of Digital Leadership on Teacher's Use of ICT: A Bibliometric Analysis. *International Journal of Academic Research in Business and Social Sciences*, *14*(6). https://doi.org/10.6007/ijarbss/v14-i6/21771

Antonopoulou, H., Halkiopoulos, C., Barlou, O., & ... (2021). Digital leader and transformational leadership in higher education. *INTED2021 …*. https://library.iated.org/view/ANTONOPOULOU2021DIG

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. https://doi.org/10.28991/esj-2021-01252

Anwar, S., & Saraih, U. N. (2024). Digital leadership in the digital era of education: enhancing knowledge sharing and emotional intelligence. *International Journal of Educational …*. https://doi.org/10.1108/IJEM-11-2023-0540

Arham, A. F., Norizan, N. S., Arham, A. F., & ... (2022). Digital leadership in education: A meta-analysis review. *... Conference on Business …*. https://doi.org/10.1007/978-3-031-26956-1_79

Avidov-Ungar, O., Shamir-Inbal, T., & ... (2022). Typology of digital leadership roles tasked with integrating new technologies into teaching: Insights from metaphor analysis. *Journal of Research on …*. https://doi.org/10.1080/15391523.2020.1809035

Basilotta-Gómez-Pablos, V., Matarranz, M., Casado-Aranda, L. A., & Otto, A. (2022). Teachers' digital competencies in higher education: a systematic literature review. In *International Journal of Educational Technology in Higher Education* (Vol. 19, Number 1). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1186/s41239-021-00312-8

Braojos, J., Weritz, P., & Matute, J. (2024). Empowering organisational commitment through digital transformation capabilities: The role of digital leadership and a continuous learning environment. *Information Systems Journal*, *34*(5), 1466–1492. https://doi.org/10.1111/isj.12501

Carvalho, A., Alves, H., & Leitão, J. (2022). What research tells us about leadership styles, digital transformation and performance in state higher education? *International Journal of Educational …*. https://doi.org/10.1108/ijem-11-2020-0514

Dieguez, T., Loureiro, P., & Ferreira, I. (2021). Higher education as an engine of entrepreneurial leadership skills in a digital area transformation. *… Management, Leadership & …*. https://search.proquest.com/openview/ab1178f9f143b933a96c6d34457b84b7/1?pq-origsite=gscholar&cbl=1796418

Duan, C. (2024). Analyses of Scientific Collaboration Networks among Authors, Institutions, and Countries in FinTech Studies: A Bibliometric Review. In *FinTech* (Vol. 3, Number 2, pp. 249–273). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/fintech3020015

Dwi Oktarina, A., Syukrul Hamdi, Ariyadi Wijaya, Zafrullah, Z., & Rashid, S. (2025). Research Trends on the Implementation of Digital Literacy in Education: A Bibliometric Analysis of the Scopus Database. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, 481–502. https://doi.org/10.23917/ijolae.v7i3.11087

Ehlers, U. D. (2020). Digital leadership in higher education. *Journal of Higher Education Policy and Leadership …*. https://johepal.com/article-1-66-en.html

Espina-Romero, L., Noroño Sánchez, J. G., Rojas-Cangahuala, G., Palacios Garay, J., Parra, D. R., & Rio Corredoira, J. (2023). Digital Leadership in an Ever-Changing World: A Bibliometric Analysis of Trends and Challenges. In *Sustainability (Switzerland)* (Vol. 15, Number 17). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/su151713129

García-Hernández, A., García-Valcárcel Muñoz-Repiso, A., Casillas-Martín, S., & Cabezas-González, M. (2023). Sustainability in Digital Education: A Systematic Review of Innovative Proposals. In *Education Sciences* (Vol. 13, Number 1). MDPI. https://doi.org/10.3390/educsci13010033

García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The Transformation of Higher Education After the COVID Disruption: Emerging Challenges in an Online Learning Scenario. In *Frontiers in Psychology* (Vol. 12). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2021.616059

Hazin, M., Yani, M. T., Trihantoyo, S., Rusdinal, R., Sulastri, S., & Rahmawati, N. W. D. (2025). Analyzing Digitalization in Education Policy in Indonesia through the Policy Analysis Triangle Model. *Journal of Posthumanism*, *5*(1). https://doi.org/10.63332/joph.v5i1.631

Jameson, J., Rumyantseva, N., Cai, M., Markowski, M., Essex, R., & McNay, I. (2022). A systematic review and framework for digital leadership research maturity in higher education. *Computers and Education Open*, *3*. https://doi.org/10.1016/j.caeo.2022.100115

Karakose, T., Polat, H., Tülübaş, T., & Demirkol, M. (2024). A Review of the Conceptual Structure and Evolution of Digital Leadership Research in Education. In *Education Sciences* (Vol. 14, Number 11). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/educsci14111166

Lien, C. M., Khan, S., & Eid, J. (2023). School Principals' Experiences and Learning from the Covid-19 Pandemic in Norway. *Scandinavian Journal of Educational Research*, *67*(5), 775–790. https://doi.org/10.1080/00313831.2022.2043430

Okunlola, J. O. (2025). Digital leadership: shaping school effectiveness in the digital era-a meta-analysis. *Educational Technology Quarterly*. https://acnsci.org/journal/index.php/etq/article/view/972

OKunlola, J. O., & Naicker, S. R. (2025). Digital Leadership in Education: A Bibliometric Analysis of Research Trends from 2010 to 2024. *F1000Research*, *14*, 687. https://doi.org/10.12688/f1000research.166667.1

Olabiyi, O. J., Vuuren, C. J. van, Du Plessis, M., Xue, Y., & Zhu, C. (2025). Digital Academic Leadership in Higher Education Institutions: A Bibliometric Review Based on CiteSpace. In *Education Sciences* (Vol. 15, Number 7). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/educsci15070846

Oyewola, D. O., & Dada, E. G. (2022). Exploring machine learning: a scientometrics approach using bibliometrix and VOSviewer. *SN Applied Sciences*, *4*(5). https://doi.org/10.1007/s42452-022-05027-7

Paul, R. (2024). University leadership in the digital age: challenges, opportunities, and critical actions. *Journal of Open, Distance, and Digital Education*. https://ojs.uni-oldenburg.de/journals/ojs2/ojs/index.php/jodde/article/view/25

Peng, Y., Alias, B. S., Mansor, A. N., & Ismail, M. J. (2024a). Charting the evolving landscape of digital leadership in education: A systematic literature review. In *Journal of Infrastructure, Policy and Development* (Vol. 8, Number 8). EnPress Publisher, LLC. https://doi.org/10.24294/jipd.v8i8.5925

Peng, Y., Alias, B. S., Mansor, A. N., & Ismail, M. J. (2024b). Charting the evolving landscape of digital leadership in education: A systematic literature review. In *Journal of Infrastructure, Policy and Development* (Vol. 8, Number 8). EnPress Publisher, LLC. https://doi.org/10.24294/jipd.v8i8.5925

Pratama, M. A. N., & Kurniady, D. A. (2021). Influence of digital leadership models on the performance of educators and educational personnel in the COVID-19 Pandemic in the first middle school. *4th International Conference on …*. https://www.atlantis-press.com/proceedings/icream-20/125952608

Purwanto, E., & Irawan, A. P. (2023). BIBLIOMETRICS ANALYSIS OF DIGITAL LEADERSHIP RESEARCH. *International Journal of Application on Economics and Business*, *1*(4), 2216–2230. https://doi.org/10.24912/ijaeb.v1i4.2216-2230

Rahmanov, F., Ganiyeva, S., Aliyeva, N., Neymatova, L., & Aghazada, T. (2025). The impact of education digitalization on achieving SDG4: A comparative assessment of Azerbaijan and SDG4 leaders. *Problems and Perspectives in Management*, *23*(2), 634–650. https://doi.org/10.21511/ppm.23(2).2025.46

Sangthong, T., & Wangthanomsak, M. (2023). Transformational Leadership of School Administrators Affecting School Management in Digital Era Under the Secondary Educational Service Area Office …. *Asia Pacific Journal of …*. https://so06.tci-thaijo.org/index.php/ajrc/article/view/265284

Shenkoya, T., & Kim, E. (2023). Sustainability in Higher Education: Digital Transformation of the Fourth Industrial Revolution and Its Impact on Open Knowledge. *Sustainability (Switzerland)*, *15*(3). https://doi.org/10.3390/su15032473

Shi, R., & Wan, X. L. (2024). A bibliometric analysis of knowledge mapping in Chinese education digitalization research from 2012 to 2022. In *Humanities and Social Sciences Communications* (Vol. 11, Number 1). Springer Nature. https://doi.org/10.1057/s41599-024-03010-8

Suksai, T., Suanpang, P., & ... (2021). A digital leadership development model for school administrators in basic education to fulfill the Thailand 4.0 policy. *Asian Interdisciplinary …*. https://so05.tci-thaijo.org/index.php/PSAKUIJIR/article/view/255268

Tanniru, M., & Peral, J. (2021). Digital leadership in education. *Effective Leadership for Overcoming ICT …*. https://doi.org/10.1108/978-1-83982-306-020211008

Tarsik, N. F., Mohamed Sawal, M. Z. H., & Arif, Z. (2025). Leadership Approaches to Digital Transformation: A Bibliometric Analysis of Emerging Trends and Insights. *International Journal of Management and Human Sciences*, *09*(01), 66–77. https://doi.org/10.31674/ijmhs.2025.v09i01.006

Terania, L. (2023). A review on developing digital leadership: assessing strategies and implications to generate links for promoting digital leadership in higher education institutions. *Journal of Interdisciplinary Perspectives*. https://jippublication.com/index.php/jip/article/view/970

Turnbull, D., Chugh, R., & Luck, J. (2021). Transitioning to E-Learning during the COVID-19 pandemic: How have Higher Education Institutions responded to the challenge? *Education and Information Technologies*, *26*(5), 6401–6419. https://doi.org/10.1007/s10639-021-10633-w

Webb, M. E., Fluck, A., Magenheim, J., Malyn-Smith, J., Waters, J., Deschênes, M., & Zagami, J. (2021). Machine learning for human learners: opportunities, issues, tensions and threats. *Educational Technology Research and Development*, *69*(4), 2109–2130. https://doi.org/10.1007/s11423-020-09858-2

Yu, K., & Ismail, A. (2024). A Bibliometric investigation of leadership and technology integration in education: Trends and insights over three decades. In *Multidisciplinary Reviews* (Vol. 7, Number 8). Malque Publishing. https://doi.org/10.31893/multirev.2024181

Zhu, C., Sun, M., Luo, J., Li, T., & Wang, M. (2023). How to harness the potential of ChatGPT in education? *Knowledge Management and E-Learning*, *15*(2), 133–152. https://doi.org/10.34105/j.kmel.2023.15.008