



# Mapping Global Trends in Digital Leadership for Quality Education: A Bibliometric and Visual Analysis From 2000 to 2025

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## ABSTRACT

Digital leadership has become a transformative paradigm for achieving quality education in the digital era. However, existing studies are mostly narrative and fragmented, offering limited understanding of how this concept evolves globally across educational contexts. This study provides a novel bibliometric and visual analysis of global research on digital leadership from 2000 to 2025. It differs from previous works by combining a PRISMA-guided approach with VOS viewer visualization to systematically map intellectual structures, thematic evolution, and collaboration networks in the field. A total of 647 journal articles indexed in Dimensions.ai were analyzed quantitatively to trace the development of digital leadership research related to quality education. The analysis examined publication trends, author networks, and dominant themes to identify conceptual and regional shifts. The results reveal a clear transition from technology-oriented and managerial perspectives to value-based and human-centered frameworks emphasizing ethics, inclusion, and sustainability. This study contributes to consolidating digital leadership as a multidimensional construct that bridges technology, pedagogy, and moral responsibility. The findings provide a conceptual foundation for policymakers and educational leaders to design strategies that promote adaptive, ethical, and future-ready leadership in alignment with Sustainable Development Goal 4 on quality education.

**Keywords:** digital leadership, bibliometric, PRISMA, quality education, VOS viewer.

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## INTRODUCTION

Quality education serves as the foundation for human development and the sustainability of civilization. In a global context, educational quality is largely influenced by the capacity of institutions and their leaders to manage change adaptively and visionarily. One of the main challenges of the 21st century is the acceleration of digital transformation, which demands technology-based leadership (Hämäläinen et al., [2021](#); Petko et al., [2022a](#)). Ideally, educational leaders are not only capable of mastering technology but also of building a vision, collaborative culture, and learning systems that respond effectively to changing times.

However, in many countries, including Indonesia, digital transformation in education often occurs reactively and unevenly, especially during crises such as the COVID-19 pandemic (Reimers et

al., [2020](#); Sá & Serpa, [2020a](#)). Many institutions lack adequate infrastructure and human resource readiness to manage online learning and digital administration. Digital inequality, resistance to technology, and limited digital leadership competencies are real obstacles to achieving inclusive and quality education (Bozkurt et al., [2021a](#); Houlden & Veletsianos, [2022a](#)). As a result, the gap in education quality is widening between regions and institutions that are capable of innovation and those that are not. The lack of leadership readiness in utilizing technology may exacerbate the learning crisis and inequality of access (Jiménez et al., [2023](#); Van Lancker & Parolin, [2020a](#)). Therefore, understanding how digital leadership is developed, researched, and implemented is crucial to ensuring the sustainability of quality education in the post-pandemic era.

In this context, digital leadership is defined as the capacity of leaders to use digital technologies to influence, organize, and drive the transformation of learning and educational management (Aas & Blomseth, [2021](#); Antonopoulou et al., [2023a](#)). This concept covers strategic, technical, and social dimensions, ranging from the use of online platforms and data-driven decision-making to the development of digital competencies among educators and students. The conceptual framework of this study positions digital leadership as an essential bridge between technological innovation and educational sustainability.

This study is unique in mapping global research trends on digital leadership in the context of quality education from 2000 to 2025, using a bibliometric approach based on Dimensions.ai. Previous studies are mostly narrative or limited case studies, while this study applies a quantitative bibliometric method supported by PRISMA and VOSviewer visualization to evaluate publication trends, researcher collaboration, dominant keywords, and thematic evolution in the field (Bui & Nguyen, [2023](#); T. Nguyen et al., [2022](#); Wang et al., [2023a](#)). Thus, this research provides a comprehensive overview of the intellectual landscape of digital leadership in education and clarifies how the discourse has shifted toward sustainability, ethics, and inclusion.

Based on this urgency, the study was designed to answer the question: what are the trends and structures of global research on digital leadership in supporting quality education over the past two decades? Specifically, the main aims of the research are to seek the answers to ten questions listed in the table below. It is hoped that the findings of this study can serve as a foundation for academics, policymakers, and practitioners to formulate strategies for strengthening digital leadership in education in a more contextual, collaborative, and sustainable manner.

**Table 1. Research Questions**

No.	Research Question
1	What are the general characteristics of the publication dataset on digital leadership?
2	What are the publication growth trends in digital leadership over time?

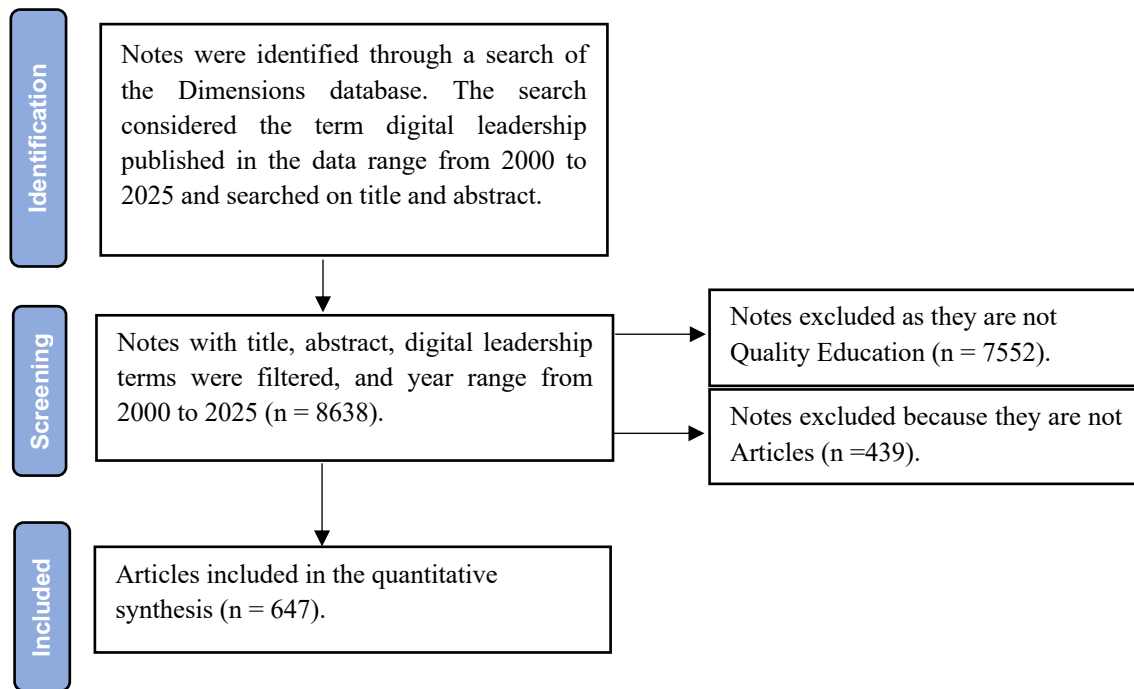
No.	Research Question
3	How frequently are digital leadership publications cited, and which ones are most influential?
4	Which journals have the greatest impact in the field of digital leadership?
5	Who are the most productive and relevant authors in digital leadership research?
6	Which authors are most frequently cited in the digital leadership literature?
7	Which institutions and countries are most active in publishing digital leadership research?
8	What are the main keywords that frequently appear in the digital leadership literature?
9	How are topics and concepts in digital leadership connected based on keyword co-occurrence?

## METHOD

This study is based on data obtained from the Dimensions.ai database, accessed on April 12, 2025, using the Boolean query “digital leadership” in the search fields Title and Abstract. The use of “educational leadership” in the earlier draft was an inadvertent error; all analyses in this study were conducted using the correct keyword “digital leadership.” The search was limited to documents published between 2000 and 2025 to capture the evolution of digital leadership research within the 21st century. The retrieved dataset was then filtered according to specific inclusion criteria: journal articles as the publication type, the fields of Education and Social Sciences, and English as the language of publication. Only articles relevant to the theme of Quality Education were retained, while conference papers, book chapters, and non-peer-reviewed documents were excluded. After applying these criteria, a total of 647 articles were included in the final dataset.

This study employed a bibliometric analysis approach guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure methodological transparency and replicability (Page et al., [2021](#)). The PRISMA process consisted of three main stages: identification, screening, and inclusion. At the identification stage, 8,638 records were initially retrieved through keyword searching. During the screening stage, 7,552 records were excluded because they did not relate to the theme of Quality Education, and 439 were removed because they were not journal articles. In the final inclusion stage, 647 eligible articles were selected for quantitative synthesis (Tricco et al., [2021](#)). The complete selection process is illustrated in Figure 1 (PRISMA Flow Diagram).

Data were analyzed descriptively and visually to identify publication growth, keyword distribution, and collaboration patterns among authors and institutions. Visualization and mapping were conducted using VOSviewer software, which generated network, overlay, and density maps to illustrate the structure and thematic evolution of digital leadership research. The application of the PRISMA framework and bibliometric visualization tools enhances the transparency, rigor, and reproducibility of the study (Page et al., [2021](#); Rethlefsen et al., [2021](#)).



**Figure 1.** PRISMA flow diagram

## RESULTS & DISCUSSION

This section will discuss publication trends in several key topics, including: number of citations, fields, publishing journals, authors with the most publications.

### **Result**

#### *Annual Publication Number*

The bibliometric search in the Dimensions.ai database identified 647 journal articles on the topic of digital leadership and quality education published between 2000 and 2025. The overall trend, as shown in Figure 2, indicates a steady increase in research output over the years. Publications were nearly absent during the early 2000s but began to rise significantly after 2010. The most substantial growth occurred after 2020, coinciding with the COVID-19 pandemic, which accelerated digital transformation and triggered a surge in academic interest in leadership within digital education contexts. The peak occurred between 2023 and 2024, signaling that digital leadership has become a major focus in educational research and policy discussions related to Sustainable Development Goal 4 (Quality Education).

The consistent rise in publications reflects a broader recognition of the critical role of leadership in managing digital change. The pandemic acted as a catalyst for both technological adoption and institutional reflection on digital readiness, prompting universities and schools to reconsider leadership capacity in digital management. The strong upward trend also illustrates how global academic

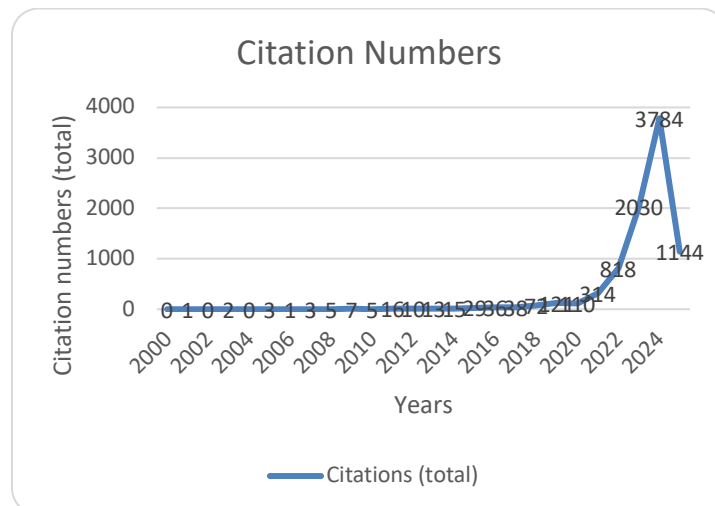
collaboration and open-access systems have facilitated the rapid diffusion of studies on digital leadership.



**Figure 2.** The number of publications on the topic per year

#### *Number of Citations*

The total number of citations related to digital leadership in the field of quality education from 2000 to 2025 reached 8,579, as displayed in Figure 3. The citation rate increased gradually from 2015 and sharply after 2020. This upward trend suggests growing recognition and academic engagement with the topic, demonstrating its conceptual and practical significance within the broader discourse of educational transformation and leadership. The increased citation frequency also indicates that digital leadership has become an influential construct in educational management and digital innovation research.



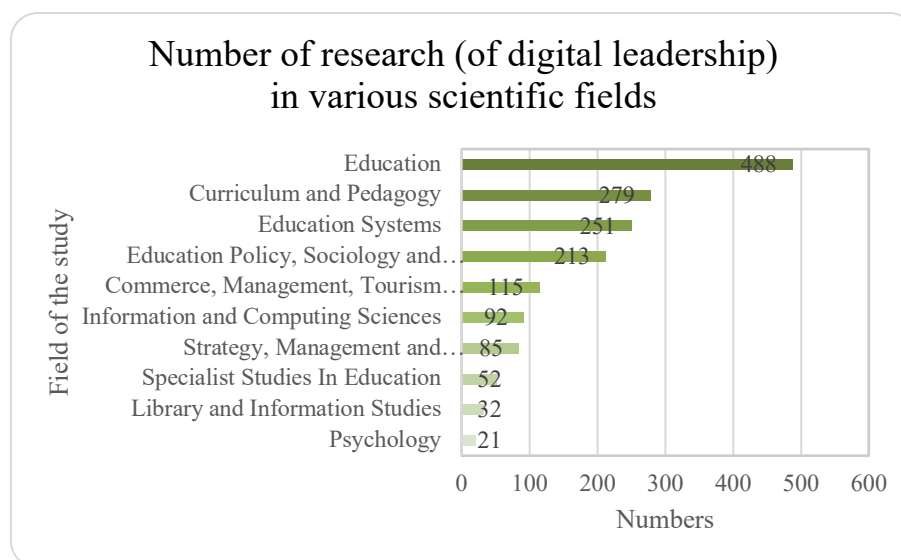
**Figure 3.** The number of citations on the topic per year

The escalation in citation activity also demonstrates a deepening of the scholarly dialogue surrounding digital leadership. As more studies address post-pandemic recovery and digital adaptation,

foundational works are increasingly referenced as theoretical anchors for new empirical explorations. The data show that digital leadership research has reached a stage of consolidation, where earlier conceptual discussions have begun to generate consistent empirical evidence and cross-disciplinary references.

#### *Publications Reviewed Based on Research Fields*

Although the main search focused on the theme of quality education, the distribution of publications across research fields (as shown in Figure 4) reveals that digital leadership intersects multiple academic domains. Besides education, substantial contributions originate from computer science, business and management, engineering, and social sciences. This indicates that digital leadership has evolved into a multidisciplinary area encompassing pedagogical, managerial, and technological perspectives.

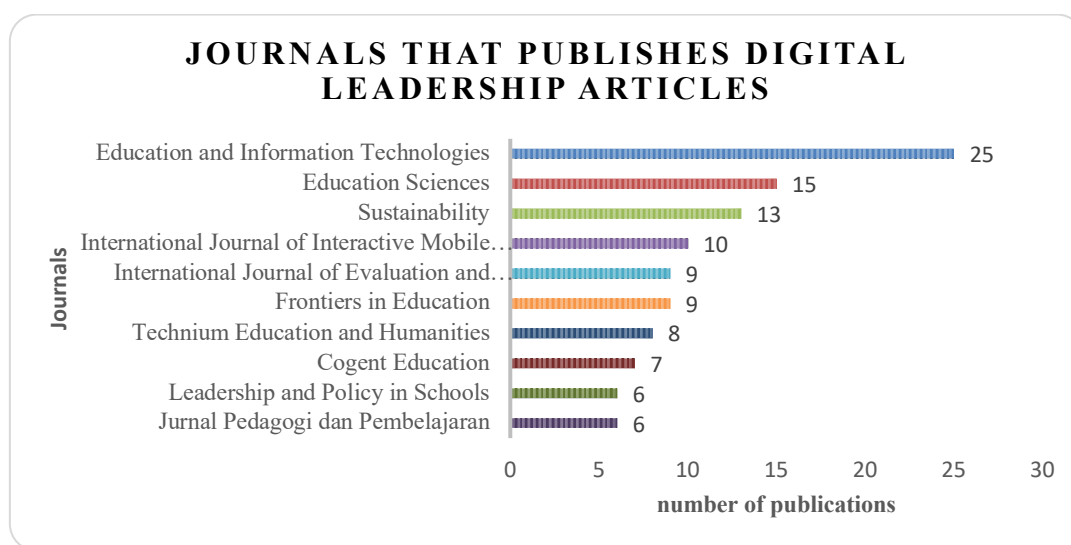


**Figure 4.** The number of research on the topic of digital leadership in various fields

The presence of diverse research fields highlights that the concept of digital leadership transcends traditional educational boundaries. The involvement of computer science reflects the growing technical dimension of leadership in digital environments, while management and social sciences contribute to the understanding of organizational behavior and innovation culture. This cross-field convergence demonstrates how the study of leadership in the digital era increasingly requires both technological insight and human-centered management perspectives.

### *Publication by Journals*

The top ten journals publishing the highest number of articles on digital leadership and quality education are presented in Figure 5. The most active outlets include Education and Information Technologies, Sustainability, Computers & Education, International Journal of Educational Management, and Journal of Educational Computing Research. These journals typically emphasize intersections between educational leadership, technology integration, and innovation. The increasing presence of publications in Sustainability reflects the growing attention to leadership for sustainable educational transformation aligned with SDG 4.



**Figure 5.** Graph of journal publishers per year

The dominance of these journals indicates that discussions on digital leadership have found a consistent platform within international academic communication networks. It also reflects the increasing openness of high-impact journals to interdisciplinary themes that bridge technology, leadership, and education. The inclusion of sustainability-focused outlets further signals an expanding research agenda that connects digital leadership with ethical, environmental, and social responsibility concerns in education.

### *Most Prolific Authors*

Analysis of author productivity identified a strong research cluster from the University of Patras, Greece, as shown in Table 2. The leading researcher, Hera Antonopoulou, contributed 13 publications, followed by Constantinos Halkiopoulos and Evgenia Gkintoni. The dominance of this institutional group demonstrates a well-established research agenda focusing on school digital transformation, digital competence, and innovation in educational management. The presence of these authors highlights Europe's central role in shaping global discourse on digital leadership between 2000 and 2025.

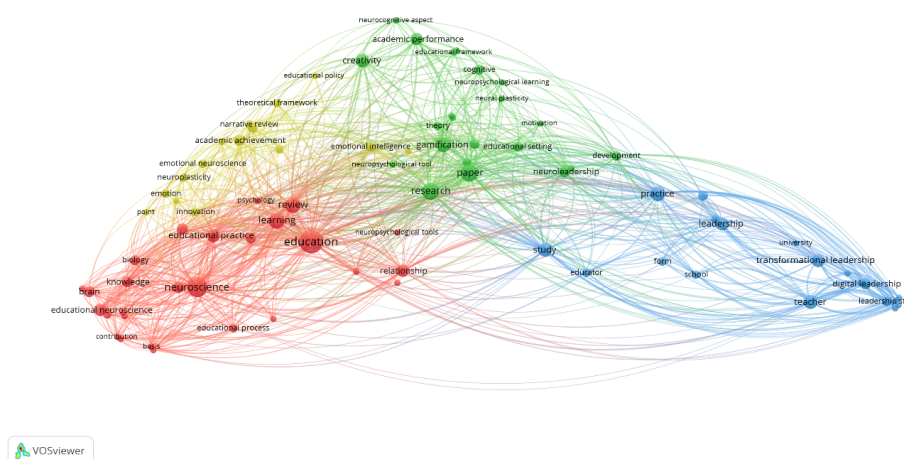
**Table 2.** Researchers with publications on the topic of digital leadership

Researcher	Number of Publication
Hera Antonopoulou	13
Constantinos Halkiopoulos	7
Evgenia Gkintoni	4
Olympia Barlou	2
Anthimos Aroutzidis	2
Grigorios N Beligiannis	2
Ioannis C Dimakos	1
Ioanna Giannoukou	1

This pattern shows that regional research ecosystems, when supported by consistent institutional collaboration, can significantly influence global knowledge production. The University of Patras cluster has become a central node in the global network, providing continuity and thematic leadership in digital leadership research. Their productivity also underscores the value of concentrated institutional efforts in advancing a specific research domain over an extended period.

#### *Co-Occurrence Network Visualization*

The keyword co-occurrence analysis using VOSviewer identified several major clusters, as illustrated in Figure 6. Prominent keywords include digital transformation, educational leadership, ICT integration, COVID-19, school management, innovation, and teacher professional development. These clusters indicate that digital leadership is often examined through both structural and pedagogical perspectives, emphasizing adaptation to technological change and human capacity development in education.



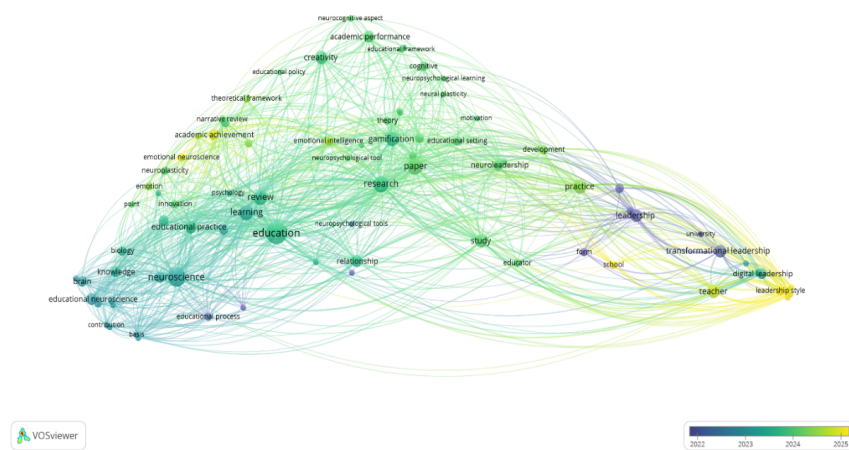
**Figure 6.** Network Visualization Map



The formation of distinct keyword clusters highlights the multifaceted nature of digital leadership research. The consistent linkage between management-oriented and pedagogical terms suggests a balance between systemic change and instructional innovation. The presence of COVID-19 and teacher development in close proximity also indicates that many studies focus on leadership's role in crisis management and professional growth within digital learning ecosystems.

#### *Co-Occurrence Overlay visualization*

The overlay visualization (see Figure 7) demonstrates a chronological shift in research focus. Early publications concentrated on terms such as ICT, e-leadership, and educational technology, while recent works highlight AI in education, digital competence, remote learning, and digital wellbeing. Emerging keywords such as resilience, equity, and digital ethics began to appear more frequently after 2020, reflecting a shift from technical approaches to value-driven and human-centered leadership research.

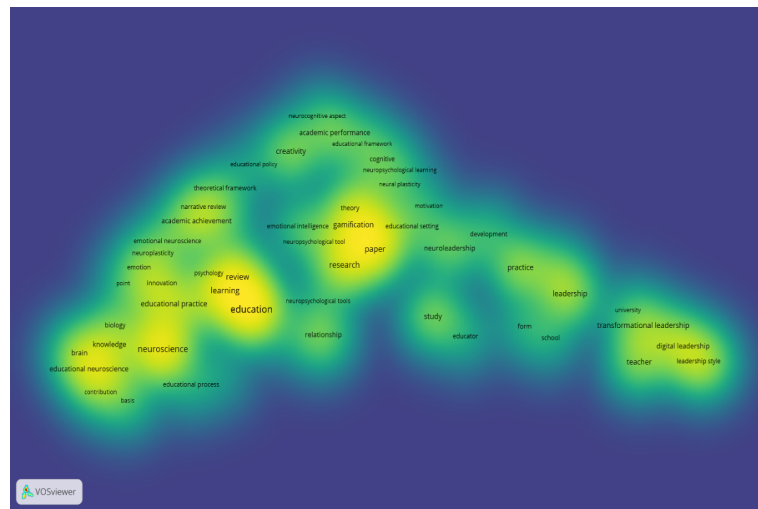


**Figure 7.** Overlay Visualization Map

The temporal layering of keywords shows a gradual evolution from instrumental uses of technology to more reflective inquiries into leadership values and ethics. The introduction of wellbeing and inclusion-related keywords indicates that digital leadership research is responding to broader societal challenges, aligning its focus with equity, access, and sustainability concerns in education.

#### *Co-Occurrence Density Visualization*

The density map (see Figure 8) reveals that high-frequency terms such as *digital leadership*, *education*, *technology integration*, *professional development*, and *online learning* represent the densest areas of research attention. Moderate-density zones include *transformational leadership*, *21st-century skills*, and *virtual learning environments*. Meanwhile, low-density regions such as *equity*, *ethics*, and *student agency* highlight potential research gaps that have not been sufficiently explored.

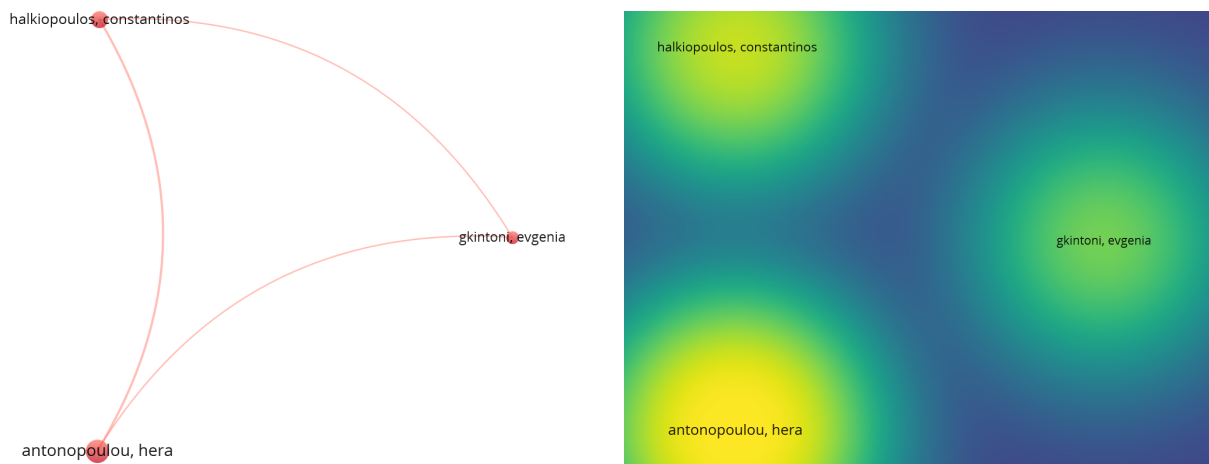


**Figure 8.** Peta Density Visualization

The visualization of density concentration also points to the maturity of certain subfields within digital leadership research. High-density keywords correspond to areas with extensive empirical validation, while lower-density areas suggest emerging interests that are yet to be systematically investigated. This distribution offers a useful map for identifying underexplored themes that may define future directions in the discipline.

#### *Co-authorship Network*

The co-authorship visualization (see Figure 9) displays multiple collaborative clusters. The largest cluster originates from the University of Patras, Greece, showing a strong pattern of institutional collaboration and thematic consistency. Smaller or isolated clusters appear in other regions, indicating that while research collaboration is growing, global connectivity across institutions and countries remains limited. These findings suggest a need to strengthen international and interdisciplinary partnerships in future digital leadership research.



**Figure 9.** Co-authorship map

Overall, the co-authorship patterns reveal that scientific productivity in this domain is concentrated among a few key groups. Although collaboration has expanded in recent years, many authors still operate independently or within national boundaries. Strengthening cross-regional networks and data-sharing initiatives could enhance the global integration and impact of research on digital leadership.

## ***Discussion***

### *Interpretative Overview*

The increasing number of publications after 2020 indicates that digital leadership has gained recognition as a pivotal component of educational transformation (Avolio et al., [2014b](#); Sugimoto & Larivière, [2018b](#); Van Lancker & Parolin, [2020a](#)). The pandemic period accelerated awareness that leadership in education must adapt quickly to technological and pedagogical disruptions (Bozkurt et al., [2021a](#); Bozkurt & Sharma, [2021](#); Reimers et al., [2020](#); Sá & Serpa, [2020a](#)). Rather than being perceived merely as a managerial or administrative function, digital leadership is now viewed as a strategic capacity to guide institutions through uncertainty and complexity. This shift resonates with the notion of adaptive and visionary leadership, where leaders must possess not only digital literacy but also the ability to nurture collaboration, motivation, and trust within digitally mediated environments (Hämäläinen et al., [2021](#); OECD, [2020b](#); Petko et al., [2022a](#); UNESCO, [2021b](#)). The steady rise in publications thus reflects a growing consensus that the quality of education in the digital age depends heavily on how leaders envision, design, and sustain technological change and become a prompt for researchers to pay attention more about the role of leaders in managing digital change in the education sectors (L. E. Kim, [2021](#); Reimers et al., [2020](#)).

### *Thematic Overview*

The increasing number of publications after 2020 indicates that digital leadership has gained recognition as a pivotal component of educational transformation (Barlou et al., [2022b](#); Garfield, [2006b](#); Gkintoni et al., [2021b](#); Zawacki-Richter et al., [2020b](#)). The pandemic period accelerated awareness that leadership in education must adapt quickly to technological and pedagogical disruptions (Bozkurt et al., [2021a](#); Dexter & Richardson, [2020b](#); Reimers et al., [2020](#); Sá & Serpa, [2020a](#)). Rather than being perceived merely as a managerial or administrative function, digital leadership is now viewed as a strategic capacity to guide institutions through uncertainty and complexity. This shift resonates with the notion of adaptive and visionary leadership, where leaders must possess not only digital literacy but also the ability to nurture collaboration, motivation, and trust within digitally mediated environments (Hämäläinen et al., [2021](#); Houlden & Veletsianos, [2022a](#); Petko et al., [2022a](#); Sheninger, [2014](#)). The steady rise in publications thus reflects a growing consensus that the quality of education in the digital age depends heavily on how leaders envision, design, and sustain technological change (Iivari et al., [2020](#)).

The thematic progression observed in the keyword analyses also illustrates a conceptual evolution in digital leadership research. Earlier studies were primarily concerned with ICT management, e-leadership, and infrastructure readiness, which reflected a technical orientation toward technology adoption. However, more recent publications increasingly highlight human-centered dimensions such as digital competence, teacher development, and well-being. The emergence of keywords such as “digital ethics,” “resilience,” and “equity” after 2020 suggests a paradigm shift from efficiency-driven to value-driven leadership frameworks. This transformation aligns with the principles of transformational leadership, where leaders act as change agents who inspire collective purpose and ethical responsibility rather than merely ensuring system performance (T. D. Nguyen et al., [2021](#); Salas-Pilco et al., [2022b](#); Warner & Wäger, [2021b](#)). As Ming and Mansor ([2024](#)) emphasize in their Digital Leaders Model, effective leaders in the digital era combine strategic thinking, global perspective, inspiration, and risk-taking with a deep sense of moral and cultural awareness.

Another emerging theme from the bibliometric mapping is the increasing integration of technological innovation and educational well-being. The overlay visualization shows that concepts such as digital well-being and inclusive education are now central to the leadership discourse. This trend indicates that the research community is increasingly aware of the psychosocial dimensions of digital transformation. Aas and Blomseth ([2021](#)) and Antonopoulou et al. ([2023a](#)) describe this as a shift toward relational leadership, where leaders cultivate both technological agility and social empathy. Such integration redefines leadership success beyond institutional metrics and moves toward the holistic

development of digital learning environments that prioritize the well-being of educators and learners alike.

The co-authorship analysis provides additional insight into how knowledge about digital leadership is produced and disseminated. The dominance of European networks, particularly the University of Patras cluster, illustrates the strength of institutional collaboration in consolidating theoretical frameworks and research continuity. European scholars have substantially shaped the conceptual foundation of digital leadership by emphasizing sustainability, inclusion, and innovation as central tenets. However, the limited participation of researchers from developing countries suggests that the global discourse remains uneven. This imbalance narrows the diversity of contextual perspectives and reduces the representativeness of digital leadership practices worldwide. Addressing this gap requires more cross-cultural collaboration and open-access partnerships that enable scholars from underrepresented regions to contribute to and benefit from the growing global knowledge base.

Beyond geographic distribution, the thematic clusters reveal a convergence between leadership studies, educational technology, and social sciences. This convergence underscores that digital leadership is not confined to a single disciplinary boundary but is inherently interdisciplinary. The integration of management theories with pedagogical innovation and digital ethics demonstrates that leadership in the digital age operates across technical, human, and moral domains (Ioannidis et al., [2021b](#)). Such convergence also signals a maturation of the field. From fragmented, domain-specific studies to a unified theoretical ecosystem that views digital leadership as both a cognitive framework and a social movement aimed at transforming educational institutions into adaptive, resilient, and inclusive learning organizations.

### *Theoretical Implication*

The findings of this study contribute to the theoretical consolidation of digital leadership as a multidimensional construct that bridges technology, pedagogy, and ethics in education (Fullan & Gallagher, [2020](#)). The bibliometric evidence shows that digital leadership has evolved from fragmented notions of e-leadership and ICT management into an integrative framework emphasizing strategic vision, digital intelligence, and relational capacity (Aas & Blomseth, [2021](#); Antonopoulou et al., [2023a](#)). The thematic and network analyses reaffirm that digital leadership theory now extends beyond managerial efficiency to encompass transformational and moral dimensions of leadership, consistent with contemporary frameworks (Williamson & Hogan, [2020b](#)). Moreover, the growing intersection between technology-driven innovation and human-centered education, as identified in recent research trends, supports the argument that digital leadership should be understood not only as a functional skill but as a dynamic form of ethical stewardship that shapes institutional culture and sustainability in the digital era (Hämäläinen et al., [2021](#); Petko et al., [2022a](#)).

### *Policy and Practical Implication*

The findings of this bibliometric study provide valuable insights for policymakers, educational leaders, and institutional planners seeking to strengthen digital leadership capacity across education systems (H. J. Kim et al., [2023b](#); Raimo et al., [2021b](#)). The growing academic emphasis on digital competence, ethical leadership, and collaboration highlights the need for policies that go beyond infrastructure development to include leadership training, professional learning communities, and cross-institutional partnerships. Integrating digital leadership frameworks into teacher and principal development programs can ensure that educational organizations are not only technologically equipped but also ethically and pedagogically responsive to digital transformation (Skutsch et al., [2022b](#)). Furthermore, the global patterns identified in this study suggest that collaboration among universities and research institutions should be expanded to bridge the gap between developed and developing contexts, enabling a more equitable exchange of knowledge and innovation aligned with the goals of Sustainable Development Goal 4 on quality education (Wang et al., [2023a](#); Zhang et al., [2021b](#)).

### **CONCLUSION**

This study confirms a key finding that digital leadership has emerged as a strategic focus in global educational research on quality education. The bibliometric analysis of 647 journal articles published between 2000 and 2025 reveals a sharp rise in publications and citations after 2020, indicating the increasing importance of digital leadership in addressing technological and pedagogical change. The results also demonstrate a thematic shift from technical and managerial orientations toward ethical, human-centered, and value-based leadership frameworks, influenced by strong institutional collaborations, particularly in Europe. Despite these insights, the limitation of this study lies in its reliance on the Dimensions.ai database and its exclusive focus on English-language journal articles, which may omit regional or non-English contributions and limit contextual depth. As a bibliometric analysis, it also cannot fully capture cultural and situational nuances in digital leadership practices. Therefore, the further research agenda should include expanding studies to developing regions to explore cultural, ethical, and well-being dimensions of digital leadership, and combining bibliometric and qualitative approaches, supported by advanced analytical tools such as topic modeling and semantic mapping, to provide deeper and more comprehensive insights into emerging global patterns and theoretical developments

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