

Mapping Research on Digital Leadership Models in Education: A Bibliometric Analysis and Future Research Directions

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Article received: Januari 2025, Revision: February 2025, Approval: March 2025

DOI: 10.17977/um025v9i22025p262

Abstract: One crucial aspect of digital leadership is the professional development of teachers through Professional Learning Community (PLC). However, literature exploring the relationship between digital leadership and PLC remains limited. This study aims to analyze research trends and developments in digital leadership and its implications for teachers' professional development using bibliometric analysis. Literature data were collected from the Scopus database for the period 2020–2024 using a Boolean Search query with keywords related to digital leadership and PLC. After filtering, 3,487 articles from various countries were selected. The analysis was conducted using VOSviewer software to identify research patterns and term network mapping. The visualization results reveal four major clusters in digital leadership research: (1) school leadership and teacher professional development, (2) experimental research and mental health in education, (3) community-based learning and qualitative research, and (4) digital transformation and transformational leadership. These findings indicate that digital leadership not only supports teacher professional development but also relates to mental well-being, innovation in community-based learning, and organizational adaptation to digital transformation. This study contributes by identifying research gaps in digital leadership and PLC and providing future research directions to explore technology-driven leadership strategies to enhance teacher professional development.

Keywords: Digital Leadership, Professional Learning Community, Bibliometric Analysis, Teacher Professional Development, VOSviewer

Digital transformation in education has shifted the leadership paradigm, requiring educational leaders to integrate technology into school management and learning processes in order to enhance teaching effectiveness and improve student learning outcomes (Timan et al., 2022). Digital leadership has become a key factor in creating an innovative, adaptive, and collaborative educational environment (Ridho et al., 2023;

Suryadi et al., 2024), with strategies that optimize the implementation of technology in schools and universities (Hamzah et al., 2021).

Various studies have shown the significant impact of digital leadership on learning effectiveness and educational innovation. Ridho et al. (2023) emphasize the importance of aligning digital resources with learning objectives, while Hamzah et al. (2021) reveal that principals with digital leadership skills are more effective in managing online learning. At the higher education level and Suryadi et al. (2024) highlight the role of transformative leadership in increasing student engagement and fostering digital innovation.

One important aspect of digital leadership is teacher professional development through a Professional Learning Community (PLC). PLCs have been proven to enhance teacher professionalism and learning quality through collaboration and reflection (Andini & Andriani, 2024). Factors such as organizational trust and self-efficacy also contribute to the effectiveness of PLCs (Guhao & Sioting, 2023) while school leadership support ensures the sustainability of these communities (Windasaro et al., 2023).

In further analysis, bibliometric methods have been used as an approach to understand the development of research on digital leadership and its impact on learning effectiveness and teacher performance within PLCs. Previous studies have examined the relationship between digital leadership and educational innovation, but there is still a gap in exploring the role of PLCs as mediators in this relationship (Alajmi, 2022; Hidayat et al., 2024). Most studies have focused more on the direct impact of digital leadership on school effectiveness, without exploring in depth how PLCs can function as a bridge to improve teacher professionalism and performance. Therefore, this study aims to analyze trends and developments in research related to digital leadership and its implications for teacher professional development through bibliometric analysis.

This research aims to identify publication trends in studies on digital leadership and PLCs through a literature analysis in the field of education, as well as to identify influential journals, institutions, authors, and countries in this area. In addition, this study also explores international collaboration networks, main research topics, and emerging issues. This study is expected to provide a comprehensive bibliometric perspective on digital leadership and PLCs in education, so that readers can gain a quick overview of the development of this field and the direction of future research.

METHOD

This study employs a bibliometric approach to analyze publications related to digital leadership and Professional Learning Communities (PLCs) in education. Data were collected from Scopus, a multidisciplinary literature database with broad coverage and high credibility. The search was conducted using a Boolean technique with the following keywords: “digital leadership” OR “educational leadership” AND “school leadership” OR “education”.

The analyzed articles were published between 2020 and 2024 and were limited to English-language academic journals to ensure international coverage. Data were collected on February 11, 2025, resulting in 3,935 publications, which, after the selection process, left 3,487 articles for analysis. The information gathered included journals, countries, institutions, authors, keywords, and references.

Data analysis and visualization were carried out using VOSviewer (version 1.6.18) to map collaboration networks among institutions and authors, as well as to identify publication trends based on keywords and citation counts. This approach helps reveal the main topics and the relationships between digital leadership and PLCs in the educational context.

RESULTS AND DISCUSSION

RESULTS

From 2020 to 2024, the number of publications on the theme of leadership has shown a significant increase, as presented in Figure 1. In 2020, there were 527 articles published, and this number continued to rise, reaching 1,040 articles in 2024. The most drastic increase occurred in the last two years, with 755 publications in 2023 surging to 1,040 in 2024. This trend indicates that research on leadership literature remains relevant for further study. Figure 2 presents the geographical distribution of these studies. The United States is the country with the highest number of publications, far surpassing other countries. Other countries with a high volume of publications include Australia, the United Kingdom, and China, all of which make significant contributions to the development of research in this field. Indonesia is also listed among the countries actively

contributing to this research, along with Malaysia, Canada, Turkey, Spain, and Israel. The results of the bibliometric analysis are visualized using VOSviewer. Figure 3 shows a network visualization of the 3,487 articles grouped into four main clusters.

Cluster 1 (Red): School Leadership and Professional Development

The red cluster highlights school leadership and teacher professional development. School leadership is not merely administrative but must also build a sustainable learning ecosystem. Research shows that Professional Learning Communities (PLCs) play an important role in enhancing collaboration between teachers and principals, which positively impacts teaching quality (Ampanon, 2024; Mallillin, 2022). Studies in developing countries such as Vietnam and Uganda also confirm the effectiveness of PLCs in improving teacher competence and student achievement (Chauraya & Barmby, 2022; Linh & Kasule, 2022).

Issues of social justice and inclusive education are key concerns within this cluster. School leadership must be oriented towards equity and cultural relevance to create an inclusive learning environment (Guthrie & Beatty, 2022). Other studies show that effective principals can increase teachers' commitment to their institutions (Sofian, 2023). In addition, the implementation of educational policies that support systemic transformation is crucial in building adaptive leadership (Liu, 2023; Taqwiem et al., 2024). The main implication of these findings is that PLCs are increasingly developing as a key strategy for teacher professional development, which can be further explored in the context of educational reform.

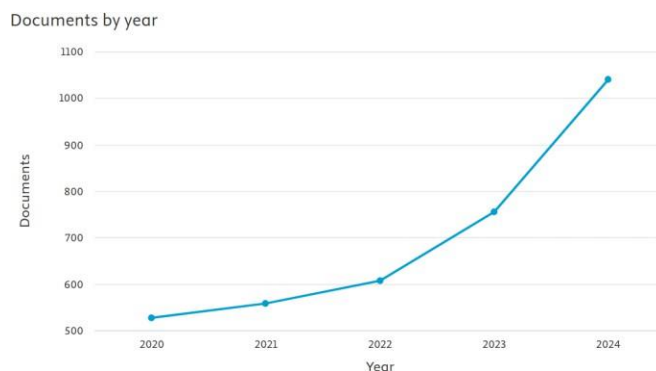


Figure 1. Number of Studies on Leadership from 2020–2024

Maghbouli et al., 2021). Mental health factors in education have become a major focus, with research showing a link between parental anxiety and children's academic burnout (Wu et al., 2022). Furthermore, mental health strategies for lecturers have been shown to help reduce burnout and improve academic well-being (Alwaely & Jarrah, 2020; Castro et al., 2023).

Issues of diversity and inclusion are also important parts of this cluster. Educational leaders must understand the concept of inclusion to create a more diverse academic environment that is responsive to students' needs (Murwanto, 2024). Research also shows that inclusive leadership can help manage cultural diversity in schools (Hurtado et al., 2021). The main implication is the need for further research on mental health within educational leadership, especially in supporting innovation and digital transformation in education systems.

Cluster 3 (Yellow): Learning and School Education

The yellow cluster focuses on the interaction between students, schools, and the learning process. Studies show that a deep understanding of school climate contributes to improving students' learning experiences and better academic outcomes (Debnam et al., 2021). Qualitative research methods dominate this cluster, with approaches such as interviews and thematic analysis providing deeper insights into educational phenomena (Aspers & Corte, 2021; Goebel & Maistry, 2022).

Issues of inclusion and diversity in learning are also key areas of focus. Inclusive education does not only address academic aspects but also ensures community engagement and equal access for all students (Oliveira et al., 2022). Other studies highlight the importance of considering diversity in qualitative research to create a more comprehensive picture of current educational challenges (Hameed, 2020). Thus, the main implication of these findings is that qualitative research plays an important role in exploring fundamental aspects of school education, particularly regarding inclusion and diversity.

Cluster 4 (Green): Transformational Leadership in Educational Digital Transformation

The green cluster analysis highlights the role of transformational leadership in addressing the challenges of digital transformation in the education sector. Effective leaders can inspire and motivate educators to adapt to technological changes, as shown by Bartsch et al., (2020), who examined how leaders supported innovation during the COVID-19 pandemic.

Organizational management and human resource aspects are also key focuses. The presence of Human Resource Information Systems (HRIS) has been shown to improve decision-making efficiency (Córcoles & Ponce, 2020). In line with this, Sari et al., (2023) emphasize the importance of leadership that is responsive to digitalization in creating an adaptive educational ecosystem.

The COVID-19 pandemic accelerated digital transformation in education, prompting school leaders to adjust their strategies to maintain educator engagement and improve job satisfaction. Research by Nousopoulou et al., (2022) shows that digitalization helps educational institutions navigate crises, highlighting the need for leaders with strong technological skills.

Based on these findings, the main implication is that transformational leadership in education must focus on the well-being of educators while simultaneously driving technological innovation. Future research directions can be focused on three main aspects: (1) Digital leadership and the effectiveness of Professional Learning Communities (PLCs) by examining how school leaders leverage technology to enhance collaboration and teacher professional development; (2) The impact of digital leadership on educators' mental well-being, by identifying factors contributing to burnout and strategies for improving work-life balance; and (3) Inclusive, technology-based leadership strategies, by developing more community-based leadership approaches to ensure that digital innovation is implemented equitably and fairly.

DISCUSSION

Digital leadership is a strategic response to the dynamic changes of the 21st century, particularly within the context of educational transformation driven by technological advancements and the demands for flexible learning. The research findings

indicate that digital leadership is not only related to the use of technology in administrative and teaching processes, but also reflects the strategic, transformative, and humanistic dimensions of the role of educational leaders (Hamzah et al., 2021; Ridho et al., 2023).

In the context of schools and educational institutions, digital leadership refers to a leader's ability to effectively utilize information technology to enhance the quality of learning, promote collaboration, and create a culture of innovation (Suryadi et al., 2024). This aligns with transformational leadership theory, which emphasizes the importance of a shared vision, inspiration, and the empowerment of organizational members to innovate and grow within a dynamic environment (Bartsch et al., 2020). Digital leadership becomes a logical extension of transformational leadership, where technology is not merely a tool but an integral part of the leadership strategy itself.

One important aspect of digital leadership in education is teacher professional development through the Professional Learning Community (PLC) approach. PLCs serve as collaborative platforms for teachers to share practices, reflect on teaching experiences, and continuously build competencies. Studies show that the effectiveness of PLCs is highly influenced by the involvement of principals with digital leadership skills, as they are capable of integrating technology into collaborative processes and teachers' professional learning (Ampanon, 2024; Windasaro et al., 2023).

Digital leadership also plays a vital role in addressing the psychological well-being of educators, particularly in the post-pandemic context. Digitally literate leaders can design flexible, technology-based work systems, provide online psychosocial support, and create adaptive and inclusive work environments (Alwaely & Jarrah, 2020; Castro et al., 2023). Therefore, modern digital leadership theory not only concerns technological proficiency but also emphasizes care for work-life balance, resilience, and emotional support for teachers (Hidayat et al., 2024).

In addition, the theories of organizational trust and teacher self-efficacy are highly relevant to understanding the relationship between digital leadership and PLC effectiveness. The study by Guhao dan Sioting (2023) shows that trust in school leaders and teachers' confidence in using technology are key factors in the success of professional learning communities. Visionary, inclusive leaders who encourage digital

collaboration directly contribute to building a supportive school culture that is open to innovation.

Another implication is the need for contextual digital leadership, especially in addressing cultural, social, and geographical diversity challenges. Several studies emphasize the importance of community-based digital leadership approaches that consider local values, community participation, and social inclusion in technology implementation (Taqwiem et al., 2024; Murwanto, 2024). Therefore, the development of digital leadership theory in the future should accommodate the diversity of educational contexts, including remote areas, inclusive schools, and communities that are underserved in terms of technology.

In the higher education sector, digital leadership has proven to have an impact on student engagement, academic performance, and campus innovation. Niță dan Guțu (2023) state that student engagement increases significantly when lecturers and academic leaders are able to combine digital strategies with participatory and transformative learning approaches. This indicates that digital leadership has a broad scope and is not limited to primary or secondary schools alone.

Despite progress in adopting digital leadership, several studies indicate that challenges remain in its implementation, such as resistance to technology, lack of training, and limited infrastructure (Alajmi, 2022; Liu, 2023). Therefore, there is a need to strengthen the digital capacity of educational leaders through continuous training, the development of educational technology policies, and the strengthening of inter-institutional collaboration networks.

Theoretically, the results of this study enrich the discourse on digital leadership by affirming that the success of digital educational transformation is not determined solely by the availability of technology, but heavily depends on leadership capacity that is adaptive, collaborative, and prioritizes the well-being of human resources. Digital leadership cannot be separated from organizational learning, transformational, and professional community theories, all of which complement each other in building a resilient and sustainable education system.

CONCLUSION AND SUGGESTIONS

CONCLUSION

Based on the co-occurrence analysis, it can be concluded that: (1) The bibliometric analysis shows that digital leadership in education is divided into four main clusters: school leadership and teacher professional development; experimental research and mental health in education; community-based learning and qualitative research; and digital transformation and transformational leadership. (2) The results confirm that digital leadership plays a significant role in the implementation of educational policies, the effectiveness of PLCs, and technology-based learning innovation, with particular attention to the mental well-being of teachers and educational leaders.

SUGGESTIONS

Based on the research findings and discussion, it is recommended that educational leaders develop comprehensive digital leadership competencies, not only in the technical aspects of technology use but also in building a collaborative culture, supporting teacher well-being, and promoting adaptive learning innovation. Training and capacity building for digital leadership should focus on strategies that enhance the effectiveness of Professional Learning Communities (PLCs), the implementation of inclusive technology, and human resource management based on data and empathy. In addition, educational policies at both national and institutional levels should support the creation of a sustainable digital ecosystem through the provision of infrastructure, technical support, and inter-institutional partnerships. Future research can be directed toward exploring digital leadership practices in greater depth across various educational levels and contexts, including in 3T areas (frontier, outermost, and disadvantaged regions), to ensure equitable and effective technology-based educational transformation.

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