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Peran Kepemimpinan Digital Kepala Sekolah dalam Membangun Budaya Sekolah yang Inovatif

The Role of School Principals' Digital Leadership in Fostering an Innovative School Culture

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Abstrak

Kata Kunci: Ketidadaan kepemimpinan digital yang kuat di sekolah akan menimbulkan berbagai dampak jangka pendek maupun jangka panjang. Pertama, integrasi teknologi akan berjalan setengah hati, hanya sebatas penyediaan perangkat tanpa transformasi dalam pedagogi. Ini dapat menyebabkan rendahnya pemanfaatan teknologi dalam pembelajaran, yang pada akhirnya membuat siswa tidak memiliki kecakapan digital yang dibutuhkan di dunia nyata. Kedua, kesenjangan digital akan semakin lebar. Siswa dari keluarga tidak mampu atau daerah tertinggal akan terus tertinggal jika kepala sekolah tidak mengambil kebijakan yang menjamin inklusivitas dan kesetaraan akses digital. Ketiga, budaya inovasi di sekolah tidak akan tumbuh, ketika pemimpin tidak memberi ruang bagi guru dan siswa untuk bereksperimen dan mengambil risiko dalam proses belajar berbasis teknologi, maka kreativitas dan daya saing pun akan menurun. Penelitian ini bertujuan untuk mengeksplorasi secara mendalam bagaimana kepala sekolah menjalankan peran sebagai pemimpin digital dalam konteks sekolah di Indonesia.

Penelitian ini menggunakan pendekatan kualitatif dengan jenis penelitian kepustakaan (library research). Pendekatan kualitatif dipilih karena dianggap paling tepat untuk memahami fenomena kepemimpinan digital kepala sekolah secara mendalam, kontekstual, dan interpretatif, serta memungkinkan peneliti mengeksplorasi makna, nilai, dan dinamika di balik praktik kepemimpinan tersebut dalam konteks pendidikan abad ke-21. Kompetensi digital sangat penting dimiliki oleh para pemimpin

sekolah dalam merencanakan dan menjalankan kebijakan berbasis teknologi secara efektif. Kompetensi ini mencakup kepemimpinan visioner, kompetensi pedagogis, literasi digital, perencanaan strategis, serta pemahaman etis dan sistematis terhadap digitalisasi. Pemimpin sekolah dituntut mampu memimpin secara kolaboratif dan adaptif, mengelola sumber daya secara strategis, serta memahami tantangan teknis dan organisasi yang kompleks dalam proses digitalisasi sekolah.

Abstract

Keywords: digital leadership; school principals; educational technology; 21st-century education; professional development; student engagement

The absence of strong digital leadership in schools can lead to various short- and long-term consequences. First, technological integration will remain superficial, limited to the provision of devices without meaningful transformation in pedagogy. This may result in low utilization of technology in learning, ultimately leaving students without the essential digital competencies required in the real world. Second, the digital divide will continue to widen. Students from underprivileged families or remote areas will fall further behind if school principals fail to implement policies that ensure inclusive and equitable digital access. Third, a culture of innovation within schools will stagnate. When leaders do not provide space for teachers and students to experiment and take risks in technology-based learning, creativity and competitiveness inevitably decline.

This study aims to explore how school principals fulfill their roles as digital leaders within the context of Indonesian schools. A qualitative approach is employed using the library research method. This approach is deemed appropriate for gaining an in-depth, contextual, and interpretive understanding of the phenomenon of digital leadership among school principals. It also allows the researcher to explore the meaning, values, and dynamics behind leadership practices in 21st-century education.

Digital competence is essential for school leaders to plan and implement technology-based policies effectively. This includes visionary leadership, pedagogical competence, digital literacy, strategic planning, and an ethical and systematic understanding of digitalization. School leaders are expected to lead collaboratively and adaptively, manage resources strategically, and comprehend both the technical and organizational challenges involved in the digital transformation of schools.

INTRODUCTION

Digital leadership in schools is an essential component of effective educational leadership in the twenty-first century. As technology becomes

increasingly integrated into classroom practice, school leaders must possess the knowledge and skills required to use digital tools and resources effectively to enhance teaching and learning. Digital leaders must

also be able to navigate the continuously evolving landscape of educational technology while fostering a culture of collaboration, creativity, and continuous improvement among staff and students.¹

By maintaining a growth mindset and remaining informed about emerging trends in educational technology, school leaders can empower staff and students to thrive in the digital era. This includes providing sustained opportunities for professional development, creating supportive and inclusive learning environments, and modelling purposeful and meaningful uses of technology. Digital leaders must also respond proactively to issues of digital equity, data privacy, and online safety so that all members of the school community can benefit from the opportunities afforded by technology. By prioritizing digital literacy and cultivating a culture of innovation, educational leaders can better prepare students to succeed in an increasingly interconnected and technology-driven world.²

The absence of strong digital leadership in schools can produce both short- and long-term consequences. First, technology integration may remain superficial, limited to the provision of devices without corresponding pedagogical transformation. This can result in limited use of technology in learning and may ultimately leave students without the digital competencies required in real-world contexts.³

Second, the digital divide may become wider. Students from low-income families or underserved regions may continue to fall behind when school principals do not

implement policies that ensure inclusive and equitable access to digital resources. Third, an innovative school culture may fail to develop. When leaders do not provide space for teachers and students to experiment and take informed risks in technology-supported learning, creativity and competitiveness may decline.⁴

A substantial body of research has emphasized the importance of digital leadership in education. For example, Dexter showed that schools characterized by strong digital leadership demonstrate higher levels of technology integration. Similarly, Schrum and Levin argued that transformational approaches to technology leadership can increase teachers' participation in instructional innovation.⁵

Nevertheless, much of the existing research has focused on developed-country contexts, where infrastructure and training systems are considerably more established. In Indonesia, research on school principals' digital leadership remains relatively limited and fragmented. For example, Sudibyo focused primarily on principals' ability to use managerial applications and did not examine how school leaders cultivate an innovative culture or promote digitally oriented professional development.⁶

Moreover, relatively few studies have directly examined the relationship between school principals' digital leadership styles and students' learning climate, teacher collaboration, and students' preparedness for a digital society. Addressing this gap is important for developing evidence-informed educational policy interventions.

¹ Virginia & Chester, n.d.; Jayson, 2020; Fidalgo, 2023

² Siddhartha & Adi, 2024; Sophia et al., 2022; Alajmi, 2022

³ Dexter, 2011; Anderson Sara L., 2005

⁴ Selwyn, 2016; Leithwood Doris, 2006

⁵ Dexter, 2011; Schrum Barbara B., 2013

⁶ Sudibyo, 2021

Several limitations can be identified in the existing literature. First, many studies remain largely descriptive and have not developed sufficiently valid models or instruments for comprehensively assessing the effectiveness of digital leadership. Second, much of the research has relied on quantitative approaches and statistical outcomes without adequately addressing qualitative dimensions, such as teachers' and students' perceptions of principals' leadership styles in digital contexts. Third, the involvement of stakeholders such as parents and local communities in supporting digital leadership has received comparatively little attention, although cross-sector collaboration is essential to a sustainable digital education ecosystem.

In response to these concerns and research gaps, this study aims to examine in depth how school principals enact their roles as digital leaders within the Indonesian school context. Specifically, the study addresses the following areas:

1. School principals' digital competence in designing and implementing technology-based policies.
2. School principals' strategies for fostering a culture of innovation and supporting teachers' professional development in the digital era.
3. The role of school principals in addressing disparities in students' digital access and literacy, particularly in areas with limited infrastructure.
4. The relationship between digital leadership styles and the student learning climate, including their implications for student engagement in technology-supported learning.

Through these objectives, the study is expected to contribute practical insights to the development of school digital-leadership models that are appropriate to the Indonesian context and to inform educational policies aimed at strengthening digital transformation in schools.

LITERATURE REVIEW

Digital Leadership in Education

A. Definition and Characteristics of Digital Leadership

Digital leadership in education refers to school leaders' capacity to use technology effectively to promote positive change and innovation within their institutions. This form of leadership requires a thorough understanding of how technology can enhance teaching and learning, together with the ability to inspire and empower others to adopt and integrate technology into everyday practice. Key characteristics of digital leaders in education include a growth mindset, a willingness to take informed risks and experiment with new approaches, strong communication skills, and a commitment to continuous learning and professional development in educational technology.⁷

Digital leaders in education also require a clear vision and the capacity to plan and implement technology initiatives strategically in ways that align with the goals and values of their school communities. They are expected to cultivate cultures of collaboration and innovation by encouraging teachers and staff to explore new tools and approaches for improving student learning. In addition, digital leaders prioritize equity and access so that all students have meaningful

⁷ Marie et al., 2020; Britta et al., 2024; Paul, 2022

opportunities to benefit from classroom technologies. By modelling effective practice and providing sustained support and training, these leaders can foster a school culture characterized by continuous improvement and growth.⁸

B. Examples of Successful Digital Leadership Implementation in Schools

School principals who encourage teachers to use diverse technological tools in their lessons can contribute to greater student engagement and improved academic achievement. Another example is the role of technology coordinators in ensuring that all students have access to appropriate devices and reliable internet connectivity, thereby promoting more equitable learning opportunities. Effective digital leaders also collaborate with stakeholders to develop comprehensive technology plans aligned with school goals and priorities, thereby supporting the sustainable integration of digital tools. In addition, they regularly evaluate the effects of technology on teaching and learning outcomes and use data to inform decision-making and continuous improvement efforts.⁹

C. Benefits of Digital Leadership for School Improvement

Digital leadership can contribute to school improvement in several ways, including strengthening student engagement and motivation, promoting collaboration among teachers, and improving communication with parents and the wider community. It can also streamline administrative processes, support personalized learning experiences, and

better prepare students for participation in a rapidly evolving digital society. By adopting appropriate digital tools and strategies, schools can create more dynamic and innovative learning environments that respond to diverse student needs and the demands of the twenty-first century. Digital leadership can further support more systematic monitoring of student progress and performance, thereby enabling more targeted interventions. Through the use of data-analysis and assessment tools, educators can identify areas of strength and difficulty in student learning and adjust instruction accordingly. Such personalized approaches may contribute to improved academic outcomes and overall student success. Digital leadership can also empower teachers to continuously strengthen their practice through professional-development opportunities and access to extensive online resources and instructional materials. Sustained professional growth and a culture of continuous learning among educators may, in turn, influence student achievement and the broader school culture.¹⁰

Fostering an Innovative School Culture

A. Definition and Characteristics of an Innovative School Culture

An innovative school culture values creativity, collaboration, and continuous improvement. It is characterized by a willingness to take informed risks, embrace change, and explore approaches beyond established routines. Within such a culture, educators are encouraged to experiment with new teaching methods, technologies, and pedagogical approaches in response to

⁸ Aidan et al., 2023; Idris, 2024

⁹ Fullan, n.d.; Raymond et al., n.d.; Marikey et al., 2021

¹⁰ Motivational Strategies of Parents and Teachers, 2024; Panjarattanakorn & Onsampant, 2023; Adera, 2025; Atobatele & Okonkwo, 2024; Saraih, 2024

diverse student needs. This type of environment can foster curiosity and enthusiasm among teachers and students and thereby strengthen engagement and motivation in the learning process. Ultimately, an innovative school culture places growth, innovation, and excellence at the center of educational practice.¹¹

A central element in fostering an innovative school culture is the provision of meaningful opportunities for professional development and collaboration among educators. By investing in sustained training and support, schools can better equip teachers to implement new ideas and strategies in the classroom. Such investment benefits individual teachers while also contributing to the success of the wider school community. Moreover, developing a culture of innovation requires a commitment to continuous improvement and a willingness to adapt to emerging challenges and opportunities. By encouraging a growth mindset and a spirit of creativity, schools can create environments in which innovation flourishes and students are empowered to realize their potential.¹²

B. Strategies for Promoting Innovation in Schools

A key strategy for promoting innovation in schools is to establish a culture that values creativity, collaboration, and responsible risk-taking. An innovative school culture encourages teachers and students to think beyond conventional approaches, experiment with new ideas, and view failure as an opportunity for learning. Such an environment not only stimulates

creativity and innovation but also strengthens a sense of community and shared purpose among members of the school. By promoting a culture of innovation, schools can better prepare students for success in a continuously changing world while empowering teachers to develop and improve their professional practice.¹³

An innovative school culture can also strengthen collaboration and teamwork among students and teachers. When individuals are encouraged to explore alternative approaches and test new ideas, they are more likely to work together to solve problems and support one another throughout the learning process. This collaborative orientation can build a stronger sense of community in which members feel valued and supported in their efforts to learn and grow. Furthermore, by cultivating a culture of innovation, schools can better prepare students for future challenges and opportunities by equipping them with the skills and dispositions needed to thrive in a rapidly changing world.¹⁴

C. The Importance of a Supportive Environment for Innovation

Creating a supportive environment for innovation is essential to fostering creativity and growth within schools. Such an environment involves not only providing resources and opportunities for innovation but also developing a culture that values and encourages responsible risk-taking and experimentation. When teachers and students feel supported in trying new approaches and thinking beyond conventional practices, they are more likely

¹¹ Rojas, 2021; Zartashia et al., 2023

¹² The Role of Educational Leadership in Fostering a Positive School Culture and Enhancing Teacher Retention, 2023; Fuad, Musa, & H., 2022

¹³ Fuad, Musa, & H., 2022; Boaler, n.d.; Stefano et al., 2020

¹⁴ Dayang et al., 2022; Mark, n.d.; Khan et al., 2025

to explore new ideas and take productive risks. This can lead to innovations in teaching and learning that may be difficult to achieve in more restrictive or traditional settings. A supportive environment can also strengthen community and collaboration as teachers and students work together to explore possibilities and address complex problems. By valuing innovation and providing the support required for it to develop, schools can create dynamic and engaging learning environments that inspire creativity and growth among all members of the school community.¹⁵

The effects of such a culture may extend beyond the classroom. Students who are encouraged to think creatively and take informed risks in their learning are more likely to develop as innovative thinkers and problem-solvers. These experiences can help prepare them for a rapidly changing world in which adaptability and creativity are highly valued competencies. By fostering a culture of innovation, schools not only contribute to the future of education but also empower students to become leaders and agents of change in their own right.¹⁶

RESEARCH METHODOLOGY

This study adopts a qualitative approach using library research. A qualitative approach was selected because it is well suited to developing an in-depth, contextual, and interpretive understanding of school principals' digital leadership and enables researchers to examine the meanings, values, and dynamics underlying leadership practices in twenty-first-century education. As emphasized by Creswell,

qualitative inquiry is particularly useful when researchers seek a comprehensive understanding of complex social phenomena that cannot be adequately explained through statistical analysis alone.¹⁷

Library research was employed because the data analyzed in this study were derived entirely from scholarly literature, including Scopus- and SINTA-indexed journal articles, academic books, policy reports, conference proceedings, and other relevant digital documents. Creswell explains that in library-based research, literature functions as a research laboratory in which ideas and theories are critically examined to generate new scholarly syntheses. Accordingly, the researchers did not conduct primary fieldwork but instead collected, evaluated, and synthesized theoretical arguments and empirical findings from credible secondary sources.¹⁸

The research was conducted systematically through several stages. First, the researchers identified the central issue and formulated the research focus on the basis of observed developments and emerging patterns in school leadership in the digital era. Second, a literature search was conducted across academic databases, including Scopus, Web of Science, ERIC, and SINTA, using the keywords digital leadership, school principals, educational technology, twenty-first-century education, professional development, and student engagement. Third, the identified sources were selected, organized, and categorized according to major themes, including principals' digital competence, educational

¹⁵ Juvonen, n.d.; Brown et al., 2024; Willingham, n.d.; Lord, 2020; Rafiana, 2024

¹⁶ Ross & Jessica, n.d.; Gilead, 2021; Ndidi & Justice, 2024

¹⁷ Creswell, 2014

¹⁸ Creswell, 2014

digitalization strategies, ICT-related challenges in schools, and the influence of leadership on teacher and student performance. Fourth, data were collected through documentation techniques involving the recording, classification, and extraction of relevant information from the selected sources. As explained by Zed, documentation is a central technique in library research and includes critical reading, note-taking, and the systematic processing of information from scholarly materials.¹⁹

During data collection, the researchers used reference-management software such as Mendeley to organize source records and maintain citation consistency. The principal sources included international publications and empirical studies from different national contexts examining digital-leadership practices at the school level.²⁰

The data were analyzed using content analysis and thematic analysis. Content analysis was employed to examine key concepts in the literature and in narratives concerning digital leadership. Thematic analysis was used to identify recurring patterns and relationships and to organize themes that appeared consistently across the selected sources. According to Braun and Clarke, thematic analysis is a flexible method for systematically identifying, analyzing, and reporting patterns or themes in data and is therefore well suited to literature-based studies.²¹

Through this approach and these procedures, the study seeks to generate a rigorous scholarly synthesis of how school principals' digital leadership influences

educational transformation and to provide a theoretical and practical foundation for policymakers, education practitioners, and future researchers seeking to develop leadership models suited to an era of technological change and globalization.

RESULTS AND DISCUSSION

1. Digital competence is essential for school leaders in planning and implementing technology-based policies effectively. This competence encompasses visionary leadership, pedagogical competence, digital literacy, strategic planning, and an ethical and systematic understanding of digitalization. School leaders are expected to lead collaboratively and adaptively, manage resources strategically, and understand the complex technical and organizational challenges associated with school digitalization. These competencies can be strengthened through sustained ICT training, systematic professional development, and the use of valid and reliable instruments to evaluate technology-leadership practices. Nevertheless, role complexity, infrastructure constraints, and the need to improve the quality of administrative management remain significant challenges. Existing good practices indicate the importance of digital-competence frameworks that support principals in guiding teachers and students and of understanding the broader effects of technology leadership on the school environment.²²

2. In the digital era, school principals play a strategic role in fostering a culture of innovation and strengthening teacher

¹⁹ Zed, 2008

²⁰ Y. Zhang et al., 2023; P. A. Baldera et al., 2025

²¹ Braun & Clarke, 2006

²² P. A. Baldera et al., 2025; Lindqvist, 2023; Håkansson Lindqvist & Pettersson, 2019; Tahir et al., 2018; Nawawi et al., 2024; Mazouak et al., 2019; Ellis et al., 2021

professionalism through differentiated professional development, visionary leadership, collaborative management, and strategic resource allocation. Digital school leaders not only encourage teachers to participate in professional networks beyond the school but also empower them to act as leaders and innovative educators. Effective technology leadership can facilitate the meaningful integration of educational technology, the management of a school's digital culture, and stronger collaboration in teaching and learning. However, principals may also face challenges such as limited recognition based on actual performance and differences in leadership approaches to student-centered learning transformation. Principals therefore play an important role in shaping the direction of school development and facilitating Professional Learning Communities (PLCs) that can directly strengthen teachers' innovation skills. Ultimately, effective leadership in cultivating an innovative culture can enhance teachers' readiness to innovate and improve overall school performance.²³

Strategy	Description
Digital Leadership	Visionary and transformational leadership to promote technology integration and innovation. ²⁴
Supportive Environment	Providing adequate infrastructure, resources, and a positive school environment. ²⁵
Differentiated Professional Development	Professional development tailored to the needs of individual teachers. ²⁶
Digital Competence and Resilience	Strengthening teachers' digital skills and resilience. ²⁷
Professional Commitment	Engaging teachers in decision-making and reflective practice. ²⁸

²³ Sterrett & Richardson, 2023; P. A. Baldera et al., 2025; W. Zhang et al., 2023; Mthanti & Msiza, 2023; Alzouebi et al., 2025

²⁴ Sterrett & Richardson, 2023; P. A. Baldera et al., 2025

²⁵ Sterrett & Richardson, 2023

²⁶ Mthanti & Msiza, 2023

Collaborative Learning	Promoting PLCs and teacher collaboration for shared learning and innovation. ²⁹
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Table 1. School principals' strategies for fostering an innovative culture and supporting teachers' professional development in the digital era.

3. The Role of School Principals in Addressing Disparities in Students' Digital Access

School principals are expected to act as technology leaders who can respond to the demands of the digital economy and promote effective technological transformation within their schools. Effective digital leaders demonstrate visionary leadership, collaborative management, adaptability, and strategic resource allocation to support technology integration, with positive implications for student learning and the overall school climate.³⁰

Major Challenges Faced by School Principals

Disparities in access to digital resources, technical skills, and understanding of e-learning policies constitute serious barriers to technology integration, particularly in underserved areas with limited infrastructure. The socioeconomic status of schools also has a substantial influence on the extent of teacher training and on teachers' capacity to integrate technology into the learning process.³¹

Strategies Implemented by School Principals

Recommended strategies include investment in ICT infrastructure, continuous professional development for

²⁷ Alzouebi et al., 2025

²⁸ Sterrett & Richardson, 2023

²⁹ Mthanti & Msiza, 2023

³⁰ W. Zhang et al., 2023; P. A. Baldera et al., 2025

³¹ Muyambi & Ramorola, 2025; Song et al., 2009

educators, and policies that ensure equitable digital access for all students. In addition, context-sensitive digital frameworks and the application of a Digital Readiness Index can help schools assess their progress in integrating technology into teaching practice.³²

Effects of Disparities in Digital Access on Learning Outcomes

Disparities in access to digital technologies, online platforms, and technology-supported learning tools can substantially affect students' academic success. This underscores the importance of equitable funding, access to digital resources, and focused professional development for educators. The digital divide can also intensify broader social inequalities, particularly across racial and socioeconomic groups, making equitable and meaningful access to technology essential for preparing all students for the twenty-first century.³³

4. The Relationship between Digital Leadership Styles and the Student Learning Climate

Digital leadership in higher education is increasingly important for supporting contemporary students, many of whom are regarded as digital natives. It is also important to understand the complex relationship between technology and educational leadership, including communication, collaboration, professional development, remote leadership, and virtual environments. Effective digital leaders demonstrate visionary leadership, collaborative management, adaptability,

and strategic resource allocation that can promote technology integration and thereby strengthen student learning and the school climate.³⁴

Effects on Student Engagement in Technology-Supported Learning

Research on the ways in which digital technologies influence student engagement remains a major concern in higher education, particularly in online and blended learning contexts. Student engagement in online learning is important for predicting academic success and is positively associated with social integration, learning processes, and student retention.³⁵

Key Characteristics of Digital Leadership in Educational Contexts

Digital leadership should be dynamic and responsive to technological developments and their educational applications. Transformational leadership plays an important role in strengthening teacher satisfaction and encouraging the adoption of digital-leadership practices, particularly in primary education.³⁶

The Influence of the Learning Climate on Student Engagement in Technology-Supported Learning

The concept of student engagement has helped researchers and educators understand how students' overall involvement in learning and task completion contributes to positive learning outcomes in digital environments. Student engagement includes psychological, cognitive, emotional, and behavioral dimensions that shape students' responses to academic and social activities in their

³² P. A. Baldera et al., 2025; Muyambi & Ramorola, 2025

³³ Muyambi & Ramorola, 2025; Williams et al., 2006

³⁴ Tandoh & Ebe-Arthur, 2017; Uzorka & Kalabuki, 2025; P. R. Baldera et al., 2025

³⁵ Pepple, 2022; MacLeod et al., 2018; Antonopoulou et al., 2025

³⁶ Zhu et al., 2025; Antonopoulou et al., 2025

efforts to achieve optimal learning outcomes.³⁷

Challenges and Opportunities in Implementing Digital Leadership in Educational Institutions

Challenges associated with digital leadership in education include resistance to change, limited digital skills, and disparities in digital competence among teachers. At the same time, digital leadership creates important opportunities through the use of data analytics, digital collaboration platforms, and infrastructure enhancement supported by continuous training to promote transparency and innovation.³⁸

Good Practices for Strengthening Student Engagement through Digital Leadership

Effective technology integration and optimal use of institutional facilities can enhance student engagement and success. Learning activities that involve problem formulation, the generation of alternative solutions, and the design of problem-solving strategies can provide appropriately challenging learning experiences and strengthen students' sense of competence in digital learning.³⁹

5. The relationship between digital leadership styles and the student learning climate plays an important role in promoting student engagement in technology-supported learning. To create inclusive and effective learning environments, educational leaders need to cultivate visionary and collaborative digital-leadership characteristics, understand the influence of the learning

climate on student motivation, anticipate emerging challenges, and capitalize on opportunities created by digital transformation.

Table 2. Relationships among Digital Leadership Styles, the Student Learning Climate, and Student Engagement

Aspect	Description
Digital Leadership Style	Digital leaders demonstrate visionary, collaborative, and adaptive leadership and manage resources strategically to promote technology integration in schools.; ⁴⁰
Additional Characteristics	Transformational leadership strengthens teacher job satisfaction and technology adoption at the primary-school level. ⁴¹
Student Learning Climate	A positive learning climate strengthens student engagement, including active participation, social interaction, and readiness for digital learning.; ⁴²
Student Engagement in Technology-Supported Learning	Student engagement encompasses psychological, emotional, cognitive, and behavioral dimensions. Higher levels of engagement are associated with stronger academic outcomes.; ⁴³
Impact of Leadership on Student Engagement	Digital leadership encourages meaningful use of learning technologies and can strengthen student interest and retention in online learning environments.; ⁴⁴
Challenges	Barriers include resistance to change, disparities in digital skills, and insufficient teacher training. ⁴⁵
Opportunities	The use of data analytics, collaborative platforms, and digital training can improve the efficiency of school management and enhance students' learning experiences. ⁴⁶
Practical Strategies	Activities such as problem-solving, solution design, and project-based learning can strengthen student engagement and students' sense of competence. ⁴⁷

Based on the results and discussion presented above, several directions for future research can be identified. First, there is a need to develop more context-sensitive assessment instruments for evaluating the effectiveness of school principals' digital leadership, particularly in educational settings with limited infrastructure. Such

³⁷ Wiseman et al., 2016; Gunuc, 2023

³⁸ Antonopoulou et al., 2025; Arees, 2025

³⁹ Gunuc, 2023; Vilhunen et al., 2025

⁴⁰ P. A. Baldera et al., 2025; Tandoh & Ebe-Arthur, 2017; Zhu et al., 2025

⁴¹ Antonopoulou et al., 2025

⁴² Wiseman et al., 2016; Gunuc, 2023

⁴³ MacLeod et al., 2018; Pepple, 2022

⁴⁴ Pepple, 2022; MacLeod et al., 2018

⁴⁵ Arees, 2025; Antonopoulou et al., 2025

⁴⁶ Arees, 2025

⁴⁷ Vilhunen et al., 2025; Gunuc, 2023

instruments should include dimensions of transformational leadership, technical competence, digital ethics, and performance-based indicators related to teacher performance and student engagement. Second, future research could examine the interaction between digital leadership styles, local school cultures, and teacher-student demographic characteristics in order to develop more adaptive and participatory strategies. In addition, data-informed policy interventions should be examined longitudinally to assess the influence of digital leadership on systemic transformation in technology-supported learning.

Nevertheless, this study has several limitations. First, although the study is presented as a systematic literature-based inquiry, most of the references reviewed originate from educational contexts in developed countries. More extensive field-based research in Indonesian schools is therefore needed to provide a more contextually grounded understanding. Second, limited access to primary data restricts the triangulation of findings between field practice and theories reported in the literature. Third, the rapidly changing nature of educational policy, particularly in relation to digitalization, may reduce the long-term relevance of some findings unless the evidence base is updated regularly. Accordingly, stronger collaboration among researchers, policymakers, and education practitioners is needed to develop digital-leadership systems that are resilient and responsive to ongoing change.

CONCLUSION

Digital leadership styles play an important role in shaping learning climates

that support student engagement in technology-supported learning environments. Transformational leadership has been associated with increased student motivation and self-efficacy, thereby contributing to a positive and participatory learning climate. Transactional leadership, meanwhile, can provide clarity of structure and expectations in digital environments and may also contribute positively to student engagement, particularly in highly digitalized higher-education contexts. Authentic leadership can further strengthen students' digital empowerment by building trust and transparent relationships between teachers and students.

Nevertheless, dimensions of leadership such as digital citizenship and visionary leadership continue to face implementation challenges, including limited alignment with student needs and insufficient effectiveness in supporting engagement.

In addition, the digital competence of both leaders and students is a critical determinant of successful technology-supported learning. Interactive and constructive learning activities supported by technology have been associated with stronger learning outcomes and student engagement. Therefore, adaptive, authentic, and skills-based approaches to digital leadership are needed to create learning environments that are inclusive, innovative, and sustainable in the contemporary digital era.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future research on digital leadership in education could examine its effects on student outcomes in greater depth. Further investigation is also needed to identify effective strategies for integrating technology into the curriculum. In addition,

research should examine the role of professional development in strengthening digital-leadership competencies among educators. Future studies could also investigate the relationship between digital leadership and school culture and identify the mechanisms through which digital

leadership contributes to broader school improvement. Continued development of knowledge in this area is essential to ensure that schools remain responsive to innovation and are able to support students' future success.

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