

THE ROLE OF LEADERSHIP IN DEVELOPING DIGITAL INFORMATION TECHNOLOGY IN ELEMENTARY SCHOOLS ON SIMEULUE ISLAND

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Abstract

The rapid advancement of digital information technology has significantly transformed the education sector, requiring elementary schools to adapt to remain relevant in the digital transformation era. This study is important because school principals play a strategic role in directing and optimizing the use of digital technology to enhance instructional quality and school management. The research aims to explore the development of digital information technology in elementary schools and examine its application in learning activities. A qualitative descriptive method was employed, using passive participant observation, semi-structured interviews, and documentation. The study involved 12 participants from SDN 2, SDN 13, and SDN 7 Simeulue, including school principals, learning community teachers, school operators, and supervisors. The findings indicate that principals hold a central role in guiding and motivating teachers to utilize digital tools for both instructional and administrative purposes. Through visionary leadership, principals encourage the integration of digital platforms into daily school activities. However, challenges remain, particularly limited internet connectivity and the fact that some teachers have not fully incorporated digital technology into their teaching practices. The study concludes that the principal's role is crucial in improving teacher competence and building an effective digital learning ecosystem. This research strengthens the literature on educational leadership in the digital era and provides practical recommendations, including continuous digital training, improved network infrastructure, and consistent digital-based management policies. Further research is recommended to evaluate the long-term effectiveness of digital training programs and their impact on classroom practices.

Keywords: Digital Information Technology, Elementary Schools, Leadership, Educational Management, Digital Transformation



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INTRODUCTION

In the rapidly evolving digital era, advances in information and communication technology (ICT) have impacted nearly every aspect of life, including education. At the elementary school level, the ability to manage and utilize digital technology is a pressing need to ensure the learning process is more effective, efficient, and relevant to the demands of the 21st century.¹ However, in island regions like Simeulue, the implementation of digital technology in schools still faces serious challenges, ranging from limited infrastructure to low digital literacy among teachers and students. In this context, the leadership of school principals plays a crucial role as the primary driver determining the direction of change through policies, motivation, and innovation in technology use. Without visionary, adaptive, and collaborative leadership, digital transformation in elementary schools risks suboptimal implementation, thus underutilizing the enormous potential of ICT in improving the quality of education.² Therefore, this research is crucial to understand the extent of the role of principal leadership in developing digital information technology in elementary schools, particularly in areas with limited geographic conditions and resources such as Simeulue Island.

The development of digital information technology in schools operates within a complex web of social boundaries, conflict dynamics, and pluralistic community contexts.³ At the social boundary level, school principals are required to act as boundary spanners who build bridges between the school community, parents, local government, and technology providers to ensure that digital initiatives can be adopted and sustained.⁴ Digital leadership literature emphasizes that the ability to negotiate these boundaries through cross-organizational collaboration, external network-building, and equitable access to technology helps reduce the digital divide within the school community.⁵ This boundary-spanning role is reflected in concrete practices such as establishing

¹ Waleed Mugahed Al-Rahmi et al., "Digital Communication: Information and Communication Technology (ICT) Usage for Education Sustainability," *Sustainability (Switzerland)*, 2020, <https://doi.org/10.3390/su12125052>.

² Raymond Sane, Lichia Saner-Yiu, and Samuel Bruelisauer, "Information and Communication Technology (ICT)," in *Encyclopedia of the Social and Solidarity Economy: A Collective Work of the United Nations Inter-Agency Task Force on SSE (UNTFSSSE)*, 2023, <https://doi.org/10.4337/9781803920924.00047>.

³ Jungsu Park, Keug Tae Kim, and Woo Hyoung Lee, "Recent Advances in Information and Communications Technology (ICT) and Sensor Technology for Monitoring Water Quality," *Water (Switzerland)*, 2020, <https://doi.org/10.3390/w12020510>; Melor Md Yunus et al., "The Use of Information and Communication Technology (ICT) in Teaching ESL Writing Skills," *English Language Teaching*, 2013, <https://doi.org/10.5539/elt.v6n7p1>.

⁴ Yi Ching Lee, Lindsey A. Malcein, and Sojung Claire Kim, "Information and Communications Technology (ICT) Usage during COVID-19: Motivating Factors and Implications," *International Journal of Environmental Research and Public Health*, 2021, <https://doi.org/10.3390/ijerph18073571>; Mohammad A. Tashtoush et al., "The Impact of Information and Communication Technologies (ICT)-Based Education on the Mathematics Academic Enthusiasm," *Journal of Educational and Social Research*, 2023, <https://doi.org/10.36941/jesr-2023-0077>.

⁵ James Sorce and Raja R.A. Issa, "Extended Technology Acceptance Model (TAM) for Adoption of Information and Communications Technology (ICT) in the US Construction Industry," *Journal of Information Technology in Construction*, 2021, <https://doi.org/10.36680/j.itcon.2021.013>.

partnerships with government agencies and connectivity providers, designing culturally sensitive technology policies, and facilitating digital culture change in schools so that innovation becomes part of a shared and sustainable work culture.

These leadership responsibilities become even more complex in areas affected by conflict, where principals must balance the development of digital technology with the urgent need for safety, stability, and continuity of learning.⁶ Research on leadership in conflict settings highlights that principals must ensure access to secure, reliable, and flexible digital solutions often through hybrid approaches that combine online and offline learning to accommodate damaged infrastructure or unstable conditions.⁷ The ability to mobilize local resources, strengthen community networks, and coordinate with humanitarian or governmental bodies becomes essential to maintaining educational continuity.⁸ Ethical considerations, including data protection and responsible use of social media, also require careful leadership attention to prevent misinformation or heightened social tensions.⁹ Thus, in conflict-impacted environments, adaptive, responsive, and safety-oriented digital leadership is indispensable in creating a resilient education ecosystem.

The complexity further deepens in pluralistic societies, where digital leadership must ensure that the integration of technology responds to cultural, linguistic, and value-based diversity within the community.¹⁰ Literature on inclusive digital leadership stresses the importance of developing digital content and policies that respect diverse identities, support marginalized groups, and promote equitable access to learning resources.¹¹ Principals must therefore lead consultative and participatory processes when determining technology platforms, design teacher training that equips them for differentiated digital instruction, and ensure that selected technologies can be

⁶ Shailendra Kumar et al., "Factors Affecting Information & Communication Technology (ICT) Adoption among MSMEs," *Journal of Open Innovation: Technology, Market, and Complexity*, 2024, <https://doi.org/10.1016/j.joitmc.2023.100205>.

⁷ Kumar et al.; Chun Mei Chou et al., "Factors Influencing Teachers' Innovative Teaching Behaviour with Information and Communication Technology (ICT): The Mediator Role of Organisational Innovation Climate," *Educational Psychology*, 2019, <https://doi.org/10.1080/01443410.2018.1520201>.

⁸ Tashtoush et al., "The Impact of Information and Communication Technologies (ICT)-Based Education on the Mathematics Academic Enthusiasm."

⁹ Loh Yoke Ling, Mohd Haniff Mohd Tahir, and Lim Chsing Chsing, "Bibliometric Visualization of Literature on Information and Communications Technology (ICT) in Education," *Jurnal Komunikasi: Malaysian Journal of Communication*, 2023, <https://doi.org/10.17576/JKMJC-2023-3901-28>.

¹⁰ Al-Rahmi et al., "Digital Communication: Information and Communication Technology (ICT) Usage for Education Sustainability."

¹¹ Farhana Yousuf, "Role of Information and Communication Technology (ICT) in Education," *International Journal for Research in Applied Science and Engineering Technology*, 2023, <https://doi.org/10.22214/ijraset.2023.54269>; Zhiyasheva Zhanar Shoraevna et al., "Teachers' Views on the Use of Information and Communication Technologies (ICT) in Education Environments," *International Journal of Emerging Technologies in Learning*, 2021, <https://doi.org/10.3991/ijet.v16i03.18801>.

localized to fit community needs.¹² Managing value conflicts that arise from digital content also demands culturally sensitive leadership capable of fostering cohesion and shared responsibility.¹³ When seen together, the roles required at the social boundary level, in conflict-affected settings, and within pluralistic communities demonstrate the deeply interconnected nature of digital leadership, highlighting that effective technology development in schools depends on adaptive, inclusive, and collaborative leadership that responds to the social realities surrounding the school.

Previous studies have emphasized that school principals play a vital role in driving digital transformation through technology-based strategic planning, strengthening ICT infrastructure, and empowering teachers to integrate digital tools into both learning and school management. These studies also indicate that implementing digital school management systems can enhance administrative efficiency and improve learning processes, although challenges such as low digital literacy among teachers and limited technological facilities remain significant obstacles.¹⁴ However, despite the growing body of research on digital leadership in schools, most investigations have focused on areas with relatively adequate technological access.¹⁵ There is still a research gap regarding how principal leadership functions in island or remote regions with limited infrastructure, uneven internet connectivity, and minimal human resources, such as those found on Simeulue Island.¹⁶ Therefore, this study is necessary to explore adaptive and context-specific leadership strategies for developing digital information technology in elementary schools located in geographically constrained and resource-limited environments.

¹² Rizka Fauziah, Isa Anshori, and Eni Fariyatul Fahyuni, "Information and Communication Technology (ICT) for Developing Islamic Education in the Era of New Normal," *KnE Social Sciences*, 2022, <https://doi.org/10.18502/kss.v7i10.11220>.

¹³ Cher Ping Lim, Hanbing Yan, and Xibei Xiong, "Development of Pre-Service Teachers' Information and Communication Technology (ICT) in Education Competencies in a Mainland Chinese University," *Educational Media International*, 2015, <https://doi.org/10.1080/09523987.2015.1005425>; Vishal Singh, ANIT DUBEY, and Chandan Sonkar, "Role of Information and Communication Technologies (ICT) in Education Sector in India," *International Journal of Creative Research Thoughts*, 2022.

¹⁴ Lim, Yan, and Xiong, "Development of Pre-Service Teachers' Information and Communication Technology (ICT) in Education Competencies in a Mainland Chinese University"; Singh, DUBEY, and Sonkar, "Role of Information and Communication Technologies (ICT) in Education Sector in India."

¹⁵ Salih Usun, "Information and Communications Technologies (ICT) in Teacher Education (ITE) Programs in the World and Turkey. (a Comparative Review)," *Procedia - Social and Behavioral Sciences*, 2009, <https://doi.org/10.1016/j.sbspro.2009.01.062>; Shpresa SULI, Amra SABOTIC, and Gentiana SADIKU-SELIMI, "Representation Of Information And Communication Technologies (Ict) In Education-Statistical Analysis," *PRIZREN SOCIAL SCIENCE JOURNAL*, 2022, <https://doi.org/10.32936/pssj.v6i2.296>.

¹⁶ Na'imah Ahmad.A. Arshood, "Information and Communication Technology (ICT) in Education of Comprehensive Methodological Foundations and Concept," *Journal of Advanced Sciences and Engineering Technologies*, 2022, <https://doi.org/10.32441/jaset.03.01.04>; Emmanuel Hans and Anjali Hans, "Role of Information and Communication Technology (ICT) in Indian Higher Education System," *YMER Digital*, 2022, <https://doi.org/10.37896/ymer21.05/c0>.

This paper aims to analyze the leadership role of principals in the development of digital information technology in elementary schools. This study aims to explore the strategic steps implemented by principals in utilizing digital technology and identify factors that support and hinder this process. Thus, it is hoped that a more comprehensive understanding of the importance of the principal's role in driving the digital transformation of education at the elementary level will be obtained. Alién also stated that a leader's ability to form or implement IT programs can not only improve student abilities but also shape a modern learning system based on global knowledge.¹⁷ In line with this, Halim also stated that leaders who are able to manage digital innovation not only contribute to improving students' technological literacy and competency but also play a role in building a modern, adaptive, and global knowledge-based learning system.¹⁸ Through visionary and digitally-minded leadership, principals can foster a learning culture that is open to change, encourage teacher creativity, and expand student access to learning resources.

Argument The proposed theory is that the leadership of a school principal who is visionary and responsive to developments in digital technology has a positive impact on improving the quality of education in elementary schools. This argument stems from the understanding that a school principal who is able to integrate ICT into management and learning can create a learning environment that is more efficient, innovative, and adaptive to students' needs. This research is expected to provide guidance for policymakers, educational practitioners, and researchers in formulating effective digital technology implementation strategies in elementary schools. Thus, digitally-minded leadership not only serves as a driver of change but also as a catalyst in creating a sustainable learning ecosystem.¹⁹ This research is expected to provide practical guidance for policymakers, educational practitioners, and researchers in formulating effective and contextual digital technology implementation strategies in elementary schools. Furthermore, these findings are also expected to strengthen the theoretical foundation regarding the importance of transformational leadership in guiding education towards an inclusive, innovative, and high-quality digital era.

¹⁷ Alién García-Hernández et al., "Sustainability in Digital Education: A Systematic Review of Innovative Proposals," *Education Sciences*, 2023, <https://doi.org/10.3390/educsci13010033>.

¹⁸ Herli Salim et al., "The Integration of Digital Technologies into Practicum Classrooms by Smartphone-Savvy Pre-Service Teachers in Indonesia," *European Journal of Educational Research*, 2023, <https://doi.org/10.12973/EU-JER.12.2.593>.

¹⁹ Ali Mohammed Bizi and Fatima Shittu, "Information and Communication Technology (ICT) and Education," *Journal of Educational and Social Research*, 2014, <https://doi.org/10.5901/jesr.2014.v4n7p88>; María L. Arancibia, Julio Cabero, and Verónica Marín, "Beliefs on Teaching and the Use of Information and Communication Technologies (ICT) by Higher Education Professors," *Formacion Universitaria*, 2020, <https://doi.org/10.4067/S0718-50062020000300089>.

RESEARCH METHODS

This study uses a descriptive qualitative design aimed at understanding real experiences and leadership practices of school principals in developing digital information technology. The design was chosen because the phenomena studied leadership, digital adaptation, and social interaction in schools can only be understood through direct engagement with the field rather than through numerical measurement.²⁰ The research was conducted in three elementary schools on Simeulue Island (SDN 2, SDN 7, and SDN 13), where digital-based systems have begun to be introduced. The study took place over four months, allowing the researcher to witness routines, leadership practices, and digital technology usage as they naturally occurred in the school environment. This design enabled the researcher to observe how principals navigate infrastructure limitations, how teachers respond to digital tools, and how the school community adapts to technological change.

The unit of analysis in this study is the leadership practices of school principals in developing digital information technology in elementary schools. This includes decision-making patterns, strategies for motivating teachers, approaches to managing limited infrastructure, and the way principals build collaboration with school operators, supervisors, and local government.²¹ The objects studied were not documents or policies alone, but behaviors, interactions, and daily routines of school actors in the field. The research subjects consisted of 12 informants: principals, community-learning teachers, school operators, and school supervisors. Observations revealed, for example, how principals intervened when the internet was unstable, how teachers sought help in using digital platforms, and how school operators handled administrative systems. Thus, the unit of analysis focused on the real, lived leadership dynamics shaping digital transformation in each school.

Data were collected through semi-structured interviews, passive participant observation, and documentation.²² Interviews allowed the researcher to capture principals' perspectives on their leadership strategies, challenges, and expectations regarding digital technology. During observations, the researcher directly witnessed classroom situations, staff meetings, the use of

²⁰ Sedat Gumus et al., "A Systematic Review of Studies on Leadership Models in Educational Research from 1980 to 2014," *Educational Management Administration and Leadership*, 2018, <https://doi.org/10.1177/1741143216659296>.

²¹ W. A. de Jong et al., "Leadership Practices in Collaborative Innovation: A Study among Dutch School Principals," *Educational Management Administration and Leadership*, 2020, <https://doi.org/10.1177/1741143220962098>; Huthaifah Khrais and Abdulqadir J. Nashwan, "Leadership Practices as Perceived by Emergency Nurses During the COVID-19 Pandemic: The Role of Structural and Psychological Empowerment," *Journal of Emergency Nursing*, 2023, <https://doi.org/10.1016/j.jen.2022.10.003>.

²² Puja Alviana Dewantri, Selvone Christin Pattiserlihun, and Putri Rahmah Nur Hakim, "Navigating Religious Hegemony and Human Rights Based on KUHP: Al-Zaytun's Controversial Case," *POROS ONIM: Jurnal Sosial Keagamaan*, 2023, <https://doi.org/10.53491/porosonim.v4i2.742>.

computers, projectors, digital attendance systems, and teachers' attempts to integrate digital tools into lessons. For example, several teachers preferred teaching manually when the network dropped, while principals often stepped in to encourage alternative offline digital resources. Documentation included ICT usage reports, school activity notes, photographs of digital tools, and records of digital administration systems. These combined techniques ensured that the study captured what people said, what they did, and what evidence remained in the school environment.

Data analysis followed the Miles & Huberman interactive model, which was applied throughout the research process. In the data reduction stage, interview transcripts, field notes, and documents were sorted to identify recurring patterns related to leadership behavior, digital adoption, and contextual challenges. Data were then displayed in matrices and thematic categories such as infrastructure limitations, leadership intervention, teacher readiness, and digital culture formation. Finally, conclusions were drawn by connecting field findings to the analytical framework, ensuring that interpretations emerged from real data rather than assumptions. Triangulation of sources (principals, teachers, operators) and triangulation of methods (interviews, observation, documentation) were used to maintain data credibility. Through this analytical process, the study uncovered clear patterns showing how principals lead digital transformation despite geographic limitations, limited literacy, and infrastructure constraints.

RESULTS AND DISCUSSION

Leadership and Management

The interview table below is presented to provide a structured overview of how principals, teachers, school operators, and supervisors carry out their roles in supporting digital transformation in elementary schools. The information summarized in the table was obtained from in-depth interviews conducted across several schools with different levels of technological readiness. This table is intended to map variations in leadership practices, identify teachers' digital competence levels, and understand the infrastructural constraints that shape technology implementation in the school context. By presenting the data in tabular form, the study highlights the practical realities of digital transformation at the school level and the diverse challenges encountered by education stakeholders.

Table 1. Principal Leadership in Digital Transformation in Elementary Schools

Participant	Main Interview Theme	Key Statement	Implication
Principal, SDN 2	Visionary Leadership	Emphasized the importance of using digital tools for administration and learning	Clearer direction for the school's digital policy
Learning Community Teacher, SDN 2	Technology Utilization	Uses learning videos but constrained by internet issues	Need to improve internet infrastructure
School Operator, SDN 2	Digital Administration System	Teachers are not yet familiar with digital administrative applications	Digital training needs to be strengthened
School Supervisor	Supervisory Support	Digital transformation has started but is not yet evenly implemented	ICT supervision needs to be reinforced
Principal, SDN 13	Digital Decision-Making	Conducts routine evaluations of technology use	Importance of continuous monitoring
Learning Community Teacher, SDN 13	Teachers' Digital Competence	Teachers began using PPT and videos	Training on digital content creation is needed
School Operator, SDN 13	Technological Infrastructure	Limited laptops; internet often slow	Need for improved devices and network connectivity
School Supervisor	ICT Implementation Challenges	Differences in teachers' digital skills hinder implementation	Training based on competency levels is required
Principal, SDN 7	Adaptive Leadership	Encourages teachers to learn technology through internal communities	A collaborative learning culture is forming
Learning Community Teacher, SDN 7	Technology Integration in Learning	Still adapting to the use of digital media	Technology integration is not yet optimal
School Operator, SDN 7	Administrative Support	Administrative applications are still done manually	Need for administrative system automation
School Supervisor	Program Evaluation	There is improvement, but not consistent	Need a long-term digital transformation plan

Source: deep interview

Based on the interview summary presented in the table, it is evident that principals across the three elementary schools consistently recognize the importance of digital technology for improving both administrative and instructional processes. Teachers reported a growing use of digital media such as videos and presentations, although their level of mastery varies significantly. School operators pointed out that administrative systems remain only partially digitized due to limited skills and inadequate technology support. Supervisors generally observed that digital

initiatives have been initiated but not yet evenly adopted, reflecting gaps in infrastructure, competence, and policy consistency among schools.

Three major trends emerge from the interview findings. First, leadership readiness appears strong, with principals showing commitment to strategic decision-making and encouraging teachers to adopt digital practices. Second, teacher digital competence remains uneven; while some teachers have begun integrating digital media effectively, others still require basic training and continuous mentoring. Third, technological infrastructure is a decisive factor, as schools with limited internet access, insufficient devices, and incomplete digital administration systems struggle to implement digital transformation optimally. These three tendencies collectively illustrate that successful digital leadership depends on the synergy between visionary leadership, competence development, and adequate infrastructure.

Recent literature on digital transformation in education emphasizes that successful technology integration requires a combination of visionary leadership, ongoing professional development, and supportive school ecosystems.²³ Digital leadership theory suggests that principals must not only guide technological adoption but also cultivate a culture of innovation that encourages experimentation and continuous learning among teachers.²⁴ Studies on teacher digital competence show that meaningful digital integration occurs when training is sustained, practical, and aligned with classroom needs, rather than delivered as fragmented workshops.²⁵ Furthermore, research on school digital ecosystems highlights that the interaction between leadership, teacher readiness, and infrastructure forms a “digital capability cycle,” where each element reinforces the other to create long-term, sustainable digital transformation.²⁶ These findings reinforce the idea that digital transformation in schools cannot rely solely on infrastructure upgrades but must be rooted in collaborative leadership and capacity-building strategies.

²³ Katyeudo K. Katyeudo and Ricardo A.C. de Souza, “Digital Transformation towards Education 4.0,” *Informatics in Education*, 2022, <https://doi.org/10.15388/infedu.2022.13>.

²⁴ Esin Mukul and Gülçin Büyüközkan, “Digital Transformation in Education: A Systematic Review of Education 4.0,” *Technological Forecasting and Social Change*, 2023, <https://doi.org/10.1016/j.techfore.2023.122664>; Tomáš Tóth et al., “Digital Competence of Digital Native Students as Prerequisite for Digital Transformation of Education,” *International Journal of Emerging Technologies in Learning*, 2022, <https://doi.org/10.3991/ijet.v17i16.31791>.

²⁵ Thao Trinh Thi Phuong et al., “Digital Transformation in Education: A Bibliometric Analysis Using Scopus,” *European Science Editing*, 2023, <https://doi.org/10.3897/ese.2023.e107138>; Serdar Türkeli and Martine Schophuizen, “Decomposing the Complexity of Value: Integration of Digital Transformation of Education with Circular Economy Transition,” *Social Sciences*, 2019, <https://doi.org/10.3390/socsci8080243>.

²⁶ Robert A. Galustov et al., “Digital Transformation of Education and the Analysis of Possible Risks: Results of a Survey of Teachers of General Education Organizations,” *Perspektivy Nauki i Obrazovania*, 2021, <https://doi.org/10.32744/PSE.2021.5.31>; Andrey D. Korol and Yury I. Vorotnitsky, “Digital Transformation of Education and Challenges of the 21st Century,” *Vyshee Obrazovanie v Rossii*, 2022, <https://doi.org/10.31992/0869-3617-2022-31-6-48-61>.

Aspects of Teacher Competence and Digital Literacy

The table below presents a summary of interview findings that illustrate how principals from three elementary schools in Simeulue carry out their leadership roles in encouraging teachers to adopt and strengthen their digital competencies. The information captures the principals' perspectives on motivating teachers, facilitating access to digital training, and addressing the challenges of technological change in remote school settings. This table is intended to highlight the different leadership strategies used to strengthen teacher readiness in utilizing ICT, especially considering the ongoing gap between teacher competence and the rapidly increasing demands of digital learning.

Table 2. Summary of Interview Discussions with School Principals

Informant	School	Description
KS	SDN 7	The principal consistently motivates teachers to utilize information technology and encourages them to participate in digital training, recognizing it as essential for developing learning.
KS	SDN 13	The principal works to facilitate teachers so they do not fall behind technological developments and strives to enhance teachers' digital literacy despite the school's remote location.
KS	SDN 2	The principal provides solutions to challenges related to technological updates to ensure ICT remains relevant to educational needs.

The interview summaries in the table reveal that all three principals share a strong commitment to strengthening teachers' digital readiness, although each adopts different approaches according to their school's context. The principal of SDN 7 emphasizes continuous motivation and encourages active participation in digital training. At SDN 13, the leadership focus is on ensuring equitable access to technology-related opportunities despite geographical limitations. Meanwhile, the principal at SDN 2 adopts a problem-solving approach by helping teachers address the challenges posed by rapid technological developments. Collectively, these descriptions indicate that principals recognize digital competence as a critical foundation for improving learning quality.

Three notable trends emerge from the interview results. First, principal motivation plays a central role in driving teachers to enhance their ICT skills, showing that leadership encouragement is a key factor in digital adoption. Second, contextual facilitation is crucial, particularly in remote schools where principals must work harder to bridge access gaps and support teachers' digital literacy development. Third, adaptive leadership behavior is evident, with principals responding to technological challenges by offering practical solutions to ensure ICT remains relevant and

effectively integrated into teaching practices. These trends collectively illustrate that effective digital leadership involves motivation, facilitation, and adaptive problem-solving abilities.

Recent literature on digital leadership in education reinforces the idea that principals play a decisive role in shaping teachers' digital competency development.²⁷ Theoretical frameworks such as transformational leadership and distributed leadership highlight that digital transformation in schools is most successful when principals combine inspiration, facilitation, and shared responsibility across the school community.²⁸ Studies in 2021–2024 show that principals who actively promote a culture of innovation, provide structured digital training, and reduce institutional barriers significantly increase teachers' willingness to integrate ICT into daily teaching practices.²⁹ Furthermore, research on professional digital competence argues that teachers' technological growth depends not only on individual motivation but also on institutional support, particularly access to continuous professional development and leadership driven digital policies.³⁰ This theoretical perspective supports the empirical patterns found in the field: schools with proactive and supportive principals tend to demonstrate stronger teacher engagement in ICT use, especially in geographically constrained regions such as Simeulue.

Evaluation of Digital Implementation

The documentation presented in this study is not merely a visual supplement but an important component in validating the interview findings related to the utilization of digital tools in elementary schools. Photographs offer concrete, observable evidence that supports the narrative statements given by principals and teachers during interviews, thereby strengthening the credibility of the data through triangulation. These visual materials capture real situations such as training sessions, discussions about digital leadership, and reflections on technology use in learning, making them essential in confirming that reported practices truly occur in the field. Thus, to provide clear

²⁷ Iryna Ivaniuk V, "Teachers' Digital Competency Development: Experience Of Scandinavian," *Information Technologies And Learning Tools*, 2019.

²⁸ Konstantin Aleksandrovich Miloradov and Galina Mikhailovna Eidlina, "Development of Teachers' Digital Competencies on the Basis of Innopolis University," *Revista on Line de Política e Gestão Educacional*, 2022, <https://doi.org/10.22633/rpge.v26iesp.2.16577>; Ember Geovanny Zumba Novay and Maritza G. Méndez-Ortega, "Development of Digital Competencies for Teachers of the Virtual Modality in Higher Education," *Espiraes Revista Multidisciplinaria de Investigación*, 2023, <https://doi.org/10.31876/er.v47i6.842>.

²⁹ Elma Marais, "The Development of Digital Competencies in Pre-Service Teachers," *Research in Social Sciences and Technology*, 2023, <https://doi.org/10.46303/ressat.2023.28>; Jo Tondeur et al., "The HeDiCom Framework: Higher Education Teachers' Digital Competencies for the Future," *Educational Technology Research and Development*, 2023, <https://doi.org/10.1007/s11423-023-10193-5>.

³⁰ Jiri Vilppola et al., "Teacher Trainees' Experiences of the Components of ICT Competencies and Key Factors in ICT Competence Development in Work-Based Vocational Teacher Training in Finland," *International Journal for Research in Vocational Education and Training*, 2022, <https://doi.org/10.13152/IJRVET.9.2.1>; Maimunatun Habibah, "Pengembangan Kompetensi Digital Guru Pendidikan Agama Islam Sekolah Dasar Dalam Kerangka Kurikulum Merdeka," *SITTAH: Journal of Primary Education*, 2022, <https://doi.org/10.30762/sittah/v3i1.11>.

visual support for the interview results, the documentation is organized and presented in Table 2.4.3 at the end of this paragraph.

Table 3. Principal Support for Strengthening Teachers’ Digital Literacy in Elementary Schools

Picture	Information	Source
	Discussion on training in the use of digital technology	Interview Document Results
	Discussion on Principals' Motivation in Utilizing Digital Technology	Interview Document Results
	Interview on the Benefits of Digital Technology in Learning Activities	Interview Document Results

Source: figure and deep interview

Table 3 contains three photographs accompanied by explanatory notes derived from interview documentation. The first image shows a discussion about training in digital technology utilization, highlighting structured efforts to strengthen teachers’ ICT skills. The second image depicts a discussion regarding the principal’s motivation in encouraging teachers to adopt digital

tools, illustrating the leadership dimension observed during field research. The third image documents an interview focusing on the benefits of digital technology in learning activities, reflecting the informants' perspectives on how ICT enhances instructional quality. All entries in the table originate from direct documentation during interview sessions, thereby serving as visual confirmation of field activities.

Three tendencies emerge from the photographic evidence displayed in the table. First, the emphasis on training activities indicates a sustained commitment to building digital competence among teachers, showing that capacity-building remains a priority in the school's digital transformation. Second, the visible involvement of the principal in discussions and guidance sessions underscores the importance of leadership presence in driving ICT adoption. Third, the documentation of interviews about ICT benefits suggests a positive orientation toward technology among school members, revealing that digital tools are increasingly perceived as valuable for enhancing teaching and learning processes. These three tendencies collectively demonstrate that digital transformation is progressing through structured training, leadership support, and an appreciative school culture toward technological integration.

These findings correspond with key theoretical perspectives on digital leadership and professional digital competence.^{31,32,33} Transformational leadership theory explains why the principal's direct engagement evident in the images acts as a catalyst for teacher motivation and behavioral change in adopting ICT.³⁴ The patterns also reflect distributed leadership principles, in which digital transformation is achieved through shared responsibilities and collaborative practices among school members.³⁵ Furthermore, the emphasis on training echoes the TPACK and

³¹ Agus Timan, Mustiningsih Mustiningsih, and Ali Imron, "Digital Leadership Kepala Sekolah Hubungannya Dengan Kinerja Guru Dan Kompetensi Siswa Era Abad 21," *JAMP : Jurnal Administrasi Dan Manajemen Pendidikan*, 2022, <https://doi.org/10.17977/um027v5i42022p323>.

³² Burhanudin Harahap, Tastaftiyan Risfandy, and Inas Nurfadia Putri, "Islamic Law, Islamic Finance, and Sustainable Development Goals: A Systematic Literature Review," *Sustainability (Switzerland)*, 2023, <https://doi.org/10.3390/su15086626>.

³³ Dahlia Haliah Ma'u, "The Harmonization of Polygamy Between Islamic Law and Legal Law in Indonesia," *Samarah*, 2023, <https://doi.org/10.22373/sjkh.v7i2.8519>; Malthuf Siroj, Ismail Marzuki, and Elkhairati, "Transformation and Future Challenges of Islamic Law in Indonesia," *Al-Istinbath: Jurnal Hukum Islam*, 2023, <https://doi.org/10.29240/jhi.v8i1.6618>; Irma Suryani et al., "Integration of Islamic Law in Regional Development in Indonesia," *Juris: Jurnal Ilmiah Syariah*, 2023, <https://doi.org/10.31958/juris.v22i1.8770>.

³⁴ Novi Andri Yani, Muhammad Kristiawan, and Alfroki Martha, "Leadership of the Principal in Improving the Professional Competence of Teachers in the Digital Age," *JPGI (Jurnal Penelitian Guru Indonesia)*, 2021, <https://doi.org/10.29210/021040jpgi0005>.

³⁵ Raúl González-Fernández et al., "Teachers' Teaching and Professional Competences Assessment," *Evaluation and Program Planning*, 2024, <https://doi.org/10.1016/j.evalprogplan.2023.102396>; Davoud Masoumi and Omid Noroozi, "Developing Early Career Teachers' Professional Digital Competence: A Systematic Literature Review," *European Journal of Teacher Education*, 2025, <https://doi.org/10.1080/02619768.2023.2229006>; Reni Herawati et al., "Does Teacher's Willingness to Change Enhance Professional Competence?," *European Journal of Educational Research*, 2022, <https://doi.org/10.12973/eu-jer.11.3.1463>.

DigCompEdu frameworks, which assert that effective ICT integration requires continuous development of teachers' technological, pedagogical, and content knowledge.³⁶ Therefore, the visual evidence in the table not only complements interview data but also illustrates how digital leadership theories materialize in practical school contexts, reinforcing the conclusion that sustainable digital transformation depends on leadership involvement, structured training, and a supportive learning culture.

CONCLUSION

The findings of this study highlight the crucial role of school leadership in strengthening teachers' digital competence and supporting the integration of information and communication technology (ICT) in elementary schools, particularly in geographically isolated regions. The results underscore that principals consistently encourage teachers to engage in digital training, provide necessary facilities, and offer solutions to challenges related to technological updates. These dynamics show that effective leadership directly influences the readiness of teachers to adopt ICT in learning, aligning with previous studies that indicate a positive relationship between teachers' digital competence and student learning experiences.

This study contributes to the growing body of literature on digital leadership in education by providing empirical insights into how principals in remote elementary schools advocate for and support ICT utilization. It enriches theoretical discussions on digital literacy enhancement in primary education and highlights the practical implications of leadership in fostering teacher innovation. Moreover, the study emphasizes that targeted facilitation, motivation, and continuous professional development programs play an essential role in strengthening teachers' capacity to adapt to digital transformations within the learning environment.

Despite its contributions, this study has several limitations that need to be acknowledged. The findings are based on a limited number of informants from only three schools, which may not fully represent the broader conditions of elementary schools in other regions. The study also relies heavily on qualitative interview data, which may be influenced by subjective interpretations from both the researchers and informants. Future research is recommended to include larger samples, comparative studies across different districts, and mixed-methods approaches to obtain more comprehensive and generalizable findings regarding leadership and ICT integration in primary education.

³⁶ Fadia Amar and Derar Eleyan, "Effect of Principals' Technology Leadership on Teachers' Technology Integration," *International Journal of Instruction*, 2022, <https://doi.org/10.29333/iji.2022.15145a>; Dawn M. Hathaway, Greta B. Gudmundsdottir, and Matthew Korona, "Teachers' Online Preparedness in Times of Crises: Trends from Norway and US," *Education and Information Technologies*, 2024, <https://doi.org/10.1007/s10639-023-11733-5>.

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