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Sustainable Education Transformation in Eastern Indonesia: The Role, Challenges, and Strategies of Digital Leadership in Developing Teachers' Digital Competencies

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ABSTRACT: The acceleration of digital transformation in the education sector requires school principals to demonstrate strong digital leadership in order to effectively support the development of teachers' digital competencies, especially in schools located in developing areas with limited infrastructure, facilities, and a lack of digital literacy among teachers. This study aimed to examine the implementation of digital leadership by school the principal, the challenges faced, and the strategic operational plans undertaken in a school located in suburban area with limited technological infrastructure and uneven digital skill. This study used a qualitative design. Data were collected through semi-structured interviews with 12 informants, followed by non-participant observation for three months and document analysis. Thematic analysis is used to identify and interpret patterns in the implementation of digital leadership, challenges encountered, and strategies applied in the context of schools with limited resources. The results of the study indicate that the principal's digital leadership is manifested through vision setting, sustainable teacher capacity building, and digital supervision, with the main constraints being limited networks, devices, and variations in teachers' digital literacy, while the strategies implemented include needs-based training, strengthening professional learning communities, digital supervision, and external collaboration. This finding confirms that adaptive digital leadership can drive digital transformation in schools even when infrastructure and competencies are limited.

KEYWORDS: Digital leadership, learning communities, teacher competence, suburban area, limited infrastructure

I. INTRODUCTION

The acceleration of digital transformation in education requires fundamental changes in school leadership styles. In the context of higher education, Jameson et al. (2022) emphasize that digital transformation requires leadership that is capable of building a strategic vision, managing a culture of innovation, and maximizing technological resources. In parallel, school principals are now required to go beyond traditional administrative functions to act as the main architects of learning digitalization, namely directing strategies, motivating teacher innovation, and allocating resources effectively to realize the institution's digital vision (Cynthia & Sihotang, 2023; Diva et al., 2022).

Within the framework of transformational leadership, digital leadership adapts with four fundamental dimensions: exemplary technology adoption (Idealized Influence), articulation of an inspiring digital vision (Inspirational Motivation), encouragement of creativity in the integration of pedagogical technology (Intellectual Stimulation), and individualized support for the development of teachers' digital competencies (Individualized Consideration) (Musid et al., 2022). This multidimensional approach requires principals to initiate innovative teacher development programs, including internal training, professional learning communities, and the systematic integration of technology into instructional planning (Nasrun et al, 2025).

The theory of digital leadership emphasizes that leadership in the digital age is not merely about mastering technology, but also about the strategic ability to facilitate organizational change through technology. According to Veithzal & Rony (2024), digital leadership encompasses visionary thinking and the ability to integrate organizational ideas to effectively execute technology projects and collaborations, as well as the ability to modify organizational behavior and outcomes in a digital context (the use of technology to influence actions, attitudes, and outcomes). In the school context, digital leadership plays a role in creating a shared vision, enhancing a digital learning culture throughout the school community, and encouraging the use of technology in teaching and learning, which includes the dimensions of visionary leadership and digital age learning culture as key guidelines for school leaders to bring about sustainable digital change.

In addition, transformational leadership theory shows strong relevance to digital leadership practices, especially in the context of teacher capacity building. Study by A'mar and Eleyan (2022) noted that digital leadership that combines professional

development strategies and school culture building significantly impacts teachers' ability to integrate technology into learning, This approach emphasizes that principals must provide systemic support through training, collaborative opportunities, and strengthening institutional culture to overcome barriers to technology adoption by teachers.

Theories of the digital divide and human resource readiness provide an additional crucial framework for understanding digital transformation in schools with limited infrastructure. In line with the concept of the second-level digital divide proposed by van Dijk (2020), these challenges go beyond mere physical access to include disparities in user motivation and digital skills. Empirical research shows that although digital leadership can facilitate transformation, limited access to technology and structural support remain major obstacles. Tondeur et al (2017) underscores the importance of mental readiness and support, as well as social connection with colleagues and students in determining teachers' acceptance and adoption to technology. Therefore, this framework emphasizes the urgency of leadership strategies that are not only visionary but also adaptive to resource inequalities. As explained by Dexter (2018), school leaders need to build responsive systems of practice to bridge competency gap, so that digital transformation can be implemented inclusively and sustainably at the secondary education level.

Previous research confirms that a principal's digital leadership is a major factor in helping teachers use technology (Reis-Andersson, 2024; Sunu, 2022). However, this is often hard to do in schools with poor infrastructure and where teachers have different skill levels (Sunu, 2022). While studies recommend useful strategies like training and collaboration (Raptis et al., 2025), there is less focus on schools with very limited resources. This study addresses that gap. This study aims to understand how school principals exercise digital leadership in the context of schools that still face infrastructure limitations and differences in digital capabilities among teachers, including the challenges that arise and the practical strategies used to support the improvement of teachers' digital competencies. The findings are expected to provide school leaders with a practical guide for advancing digital transformation incrementally in resource-constrained settings. Additionally, the study offers implications for policymakers and stakeholders, emphasizing the critical need for aligned infrastructure support, targeted training, and adaptive leadership to enable a more equitable and sustainable school digitization process.

II. METHODS

This study used a qualitative case study design to investigate digital leadership practices in a real-world context, in line with Yin's (2018) guidelines, which emphasized the relevance of case studies for understanding complex social phenomena in their natural environment. This approach allowed researchers to gain an in-depth picture of how leadership practices took place, how actors were involved in the process, and how contextual factors influence the dynamics of digitization in schools. The study was conducted at SMA Negeri 1 Kabila senior public high school in Bone Bolango Regency, Gorontalo Province, Indonesia. The school was selected purposively based on evidence of active digital integration initiatives.

Data collection was conducted over a period of three months through semi-structured interviews, non-participatory observation, and document analysis. Twelve informants were selected using purposive and snowball sampling techniques to ensure diversity of perspectives, including school leaders, teachers, and other relevant stakeholders. Interviews lasted between 60 and 90 minutes, were recorded with the participants' consent, and were transcribed verbatim. Observations included learning sessions and training activities, while document analysis covered school policies, training materials, supervision reports, and digital learning artifacts. The use of multiple data collection techniques allowed for triangulation, which strengthened the accuracy of the findings.

Data analysis followed the six phases of Braun and Clarke's (2006) thematic analysis, including familiarization, initial coding, theme development, theme review, theme naming, and report writing with supporting evidence from field data. Software NVivo 12 was used to assist with data organization and the coding process. Saturation was achieved after ten interviews, with two additional interviews ensuring that no new themes emerged. The validity of the findings was maintained through adequate field involvement, triangulation across methods and sources, and member checking to verify the participants' interpretation of the data. Ethical considerations were met through approval from relevant institutions, informed consent from all participants, and the implementation of confidentiality and research data security procedures.

III. RESULTS

A. The Role of School Principals in Developing Digital Competence of Teachers

Based on study results, principals played a digital leadership role as vision makers, facilitators, capacity builders, and supervisors. By establishing a vision and direction for school digitization, principals developed a digital vision collaboratively with vice principals, teachers, administrative staff, and other stakeholders. This vision encompassed the digitization of administration, curriculum, counseling services, and student activities. The implementation of this vision was evidenced by the establishment of mandatory digital training for all teachers and educational staff, as well as the integration of technology into school operational procedures. In addition to formulating the vision, principals also initiated steps to strengthen digital governance, such as implementing computer-based data management and utilizing digital platforms to support supervision and administrative tasks.

Facilitation efforts were demonstrated through the provision and enhancement of relevant technological infrastructure, which encompassed high-speed internet networks, computer maintenance, and the allocation of laptops for strategic work units. The school also utilized four computer laboratories and collaborated with internet service providers to ensure more stable digital access, while optimizing the use of teachers' and students' personal devices when necessary. In addition to providing infrastructure, the principal encouraged the development of teacher competencies through the learning community known as SPIRIT SMANKAB, which regularly conducted workshops and training sessions. These included instruction on tools such as Canva and Google Sites, digital media creation, and individual mentoring for teachers requiring additional support. This comprehensive approach illustrated a deliberate combination of facility improvement, strengthened teacher capacity, and sustained operational support.

B. Obstacles in Implementing Digital Leadership

Based on the study results, there are obstacles to the implementation of digital leadership in the school, particularly related to the technical aspects of infrastructure. Although Wi-Fi had been made available to teachers, students, the library, and laboratories, thereby providing wider internet access than before, network disruptions and unstable power supplies continued to hamper the digital learning process. In practice, connection failures periodically prevented students from accessing online learning materials, which forced teachers and students to rely on alternatives such as mobile tethering or locally stored content. This reliance on an inconsistent network also affected material delivery strategies, such as distributing resources via video links or digital books. While this demonstrated adaptive problem-solving, it simultaneously underscored how persistent infrastructure limitations undermined the overall effectiveness of the school's digital transformation.

In addition to technical obstacles, variations in digital literacy levels among teachers also posed a significant barrier. Field findings revealed that younger teachers were generally quicker to adopt new digital tools, while more senior teachers required more intensive support and guidance to utilize technology optimally. These variations created a tension between the drive for innovation and individual comfort zones, necessitating careful navigation by school leadership. Nevertheless, teachers generally maintained a positive attitude toward technology and actively sought to adapt by participating in workshops and integrating technology into their teaching practices. Another identified challenge was the symbolic nature of teacher appreciation, which was perceived as insufficient to motivate sustained professional development in the face of continuously evolving digital demands.

C. Strategic Approaches to Develop Teacher Capacity Sustainably

The study results indicated that the school principal implemented a structured strategic approach to strengthen teachers' digital competencies, centered on regular, needs-based training programs. This training was conducted continuously through the SPIRIT SMANKAB professional learning community, focusing on the practical application of digital platforms, the development of teaching modules, the creation of digital presentations, and the production of educational videos. Each training session was systematically followed by practical assignments to ensure the immediate application of newly acquired skills. A critical component of this approach was peer mentoring, wherein more proficient teachers were tasked with supporting their less experienced colleagues, while teachers requiring assistance were actively encouraged to seek guidance. This systematic yet adaptive mechanism enabled the entire teaching staff to progress collectively, despite significant variations in their initial levels of digital proficiency.

In addition to technical training, the principal strengthened the learning ecosystem by forming a professional learning community (PLC) through SPIRIT SMANKAB. This community regularly conducted reflective sessions, evaluations of teaching practices, and collaborative projects to develop digital learning media. This approach was reinforced by the implementation of digital-based academic supervision, which utilized tools such as Google Forms and Excel to monitor teacher performance. The integration of digital supervision accelerated the monitoring process, enhanced transparency, and facilitated more systematic feedback. Collectively, these strategies demonstrated the school leadership’s commitment to cultivating a sustainable digital culture, achieved through a deliberate combination of targeted training, professional collaboration, and data-informed evaluation.
The roles, challenges, and strategies implemented by the digital leadership of the principal of SMAN 1 Kabila can be illustrated as follows.

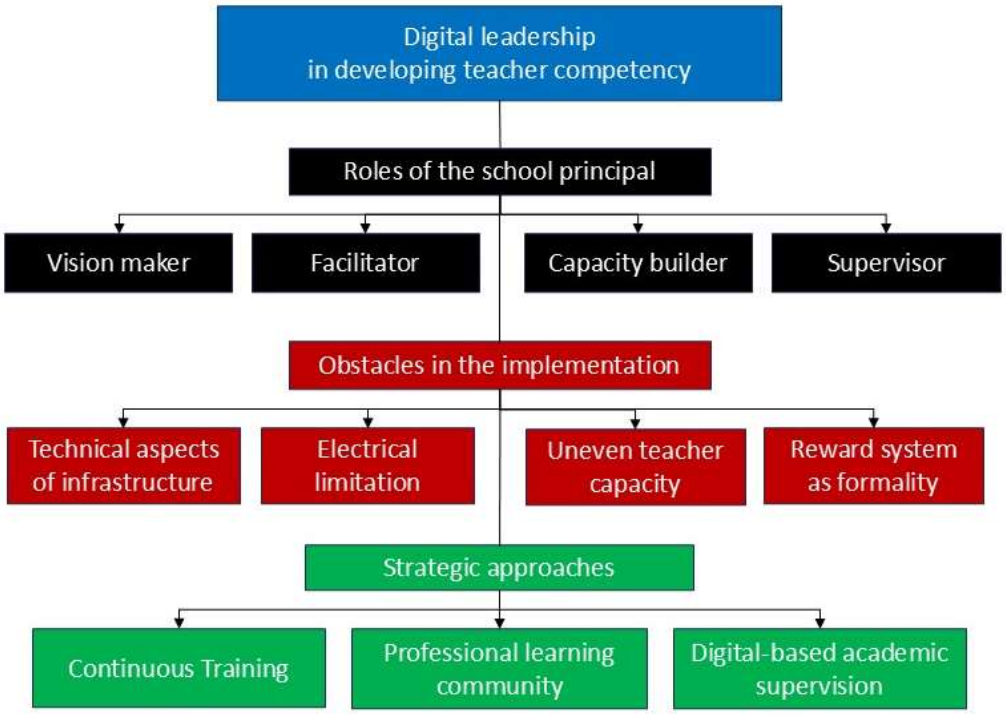

Figure 1. The relationship between digital leadership roles, obstacles, and strategies implemented by the principal in an effort to improve teachers' digital capabilities in SMKN 1 Kabila Gorontalo.

IV. DISCUSSION

Based on the findings of the study, the digital transformation effort at SMA Negeri 1 Kabila was undertaken by the principal through the adoption of digital leadership. This process was supported by three interconnected key elements: the role of the principal as a digital vision maker, facilitator, and supervisor. This finding is consistent with the concept of digital leadership, which positions leaders as strategic visionaries who establish a digital direction together with all stakeholders (Veithzal & Rony, 2024). The digital vision in schools is not only decided top-down but also formulated together with the vice principal, teachers, and administrative staff, reflecting the importance of collaboration in setting adaptive institutional goals in the digital age. The implementation of this policy is evident through mandatory digital training for all teachers and educational staff and the integration of technology into school operational policies, which is in line with a study showing that principals must actively facilitate changes in the culture of digital learning to support the adoption of technology by teachers (A'mar & Eleyan, 2022).

The digital infrastructure facilitation efforts carried out in this school also reflect a combination of technical provision and strategic support that has often been discussed in previous research on the digital transformation of education. The school provides internet access, device maintenance, and cooperation with external service providers to overcome resource constraints, demonstrating an awareness of technical barriers. The existence of four computer laboratories, optimization of digital devices, and the use of teachers' and students' personal devices are responses to infrastructure challenges that have been reported as part of the digital divide in many schools in developing countries (Sunu, 2022). In addition, teacher capacity building through the SPIRIT SMANKAB professional learning community demonstrates an approach that is in line with the OECD Education Working Papers No. 224 recommendation that needs-based training and continuous mentoring are key to improving teachers' pedagogical skills in a digital context (Gouëdard et al, 2020). This approach appears to encourage the growth of digital competencies through workshops, structured training, and individual mentoring, which supports the idea that sustainable human resource development is an important component of digital leadership in schools.

The results of this study are also in line with other studies that examine teachers' professional readiness, which show that there are differences in technical competency levels that require differential support and contextual professional learning strategies (Ertmer & Ottenbreit-Leftwich, 2010; Tondeur et al., 2017). Effective digital leadership not only provides general training but also adapts coaching approaches to individual needs, including peer mentoring and collaborative learning, as advocated by the literature on teachers' digital capabilities (Koehler & Mishra, 2009). In this case, the principal's response through workshops, learning communities, and mentoring demonstrates a transformative effort in line with OECD Education Working Papers No. 224 recommendations (Gouëdard et al, 2020), although the existing symbolic appreciation does not yet optimally support internal motivation and the sustainability of professional learning. These findings emphasize that digital leadership in a context of resource

disparities requires an adaptive, collaborative, and sustainable approach to overcome structural barriers and support more equitable improvements in teacher capabilities.

The principal's continuous training strategy is in line with the literature on teacher professional development in digital transformation. Research shows that needs-based and hands-on training is the most effective approach to improving teachers' ICT competencies because it allows for the adaptation of learning to the real context and needs of the classroom (Darling-Hammond et al., 2017; Tondeur et al., 2016). The peer mentoring implemented through SPIRIT SMANKAB is also consistent with the concept of peer coaching, which has been proven to increase teachers' confidence and skills in technology integration (Oberer & Alptekin, 2018).

The formation of professional learning communities (PLCs) demonstrates how digital leadership can institutionalize teacher collaboration, consistent with the PLC framework that emphasizes continuous reflection, collective problem solving, and sharing best practices (DuFour & Eaker, 1998; Vangrieken et al., 2017). The integration of digital-based academic supervision using Google Forms and Excel is in line with the global trend of utilizing data-driven decision-making in school management (Reeves, 2017). This strategy improves efficiency, accountability, and the quality of feedback received by teachers. Overall, the principal's strategic approach demonstrates the implementation of comprehensive digital leadership as recommended by Jameson et al. (2022), namely by combining competency development, professional collaboration, and data-based management to strengthen the digital learning ecosystem in a sustainable manner.

This study has several limitations. As a single-case study, its findings cannot be generalized broadly, particularly since not all schools possess leadership characteristics similar to those identified at SMA Negeri 1 Kabila. Furthermore, while the three-month data collection period provided rich insights, it was insufficient to capture the long-term dynamics and sustainability of digital practices. A longitudinal study would be more effective in mapping the ongoing development of digital competencies. Additionally, the absence of student learning outcome data limited the ability to assess the ultimate impact of digital leadership practices on learning enhancement. Therefore, future research should integrate measures of student performance and examine the relationships between digital leadership, teacher competency development, and student learning achievements as more comprehensive indicators of educational impact.

CONCLUSION

The digital leadership of school principals plays a significant role in directing the development of digital-based learning through vision formation, collaborative facilitation, teacher capacity building, and supervision and evaluation of digital practices. This implementation enables the pedagogical integration of technology, despite obstacles such as limited basic infrastructure and variations in teachers' digital skills. The strategies applied, including continuous training, optimization of digital platforms, and more effective internal coordination, contribute to the creation of a more adaptive and sustainable learning ecosystem. The implications of this research emphasize the importance of consistent digital leadership as the foundation for school transformation, while also highlighting the need for policy support and resource investment that enables digital learning practices to develop sustainably.

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