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Strategies to improve teacher competence in elementary schools through information technology-based learning

Hafsah*)[1], Ismail[2], Nasir Usman[3], Murniati A.R[4], Munawar Fajri[5]
[1]Universitas Syiah Kuala, Banda Aceh, Indonesia; hafsah24@mhs.usk.ac.id
[2]Universitas Syiah Kuala, Banda Aceh, Indonesia; ismail.kutaradaja@usk.ac.id
[3]Universitas Syiah Kuala, Banda Aceh, Indonesia; nasir@usk.ac.id
[4]Universitas Syiah Kuala, Banda Aceh, Indonesia; murniati@usk.ac.id
[5]Universitas Syiah Kuala, Banda Aceh, Indonesia; munawar24f@mhs.usk.ac.id
*)Corresponding author: Hafsah; E-mail addresses: hafsah24@mhs.usk.ac.id

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Abstract. This study aims to explain IT Training for teachers, the availability of adequate facilities and infrastructure, and Structural support from the school. This study uses a descriptive qualitative approach to map the competencies of elementary school teachers in information technology. Primary data in this study were obtained through observations in schools and through internet searches (Google). This research was conducted at SDN 2 Sampoiniet. The population used in this study totaled 10 (ten) people, consisting of the principal and teachers. The object of this research is Information Technology-Based Learning. Data analysis techniques using the Miles and Huberman approach, which consists of three steps: (1) presenting findings, (2) describing patterns and trends, and (3) understanding the underlying meaning. The research results show that improving teacher competence in Elementary Schools is crucial. Improving teacher competence cannot be done carelessly. A sustainable strategy is needed, such as training programs that focus on using technology in education, professional development, and teacher collaboration. Access to digital resources and institutional support is also very important for ensuring that teachers can adapt to change and use technology to the fullest.

Introduction

Teachers in formal education are the primary actors responsible for creating knowledgeable, skilled, and characterful future generations. The quality of education students receive largely depends on the teacher's competencies, including knowledge, pedagogical skills, and innovative teaching (Noor & Wathoni, 2020; Sirait, 2021). As the vanguard of the education process, teachers must have sufficient competence to educate students effectively. This competence includes the ability to master subject matter, use effective teaching methods, and create a supportive learning environment (Nisak et al., 2024; Susanto et al., 2024). However, as times change, the challenges teachers face are increasingly complex, especially with the rise of information technology in education. For this reason, teachers need to continue developing their competencies to keep up with these developments.

Strategies to improve teacher competence in schools through information technology-based learningis something that must be done by every teacher at various levels of education (Widana & Ratnaya, 2021). However, several studies have not focused on strategies to improve teachers' competence in elementary schools through information technology-based learning. Some previous studies include: *First,* a study that discusses strategies to improve teacher competence through information technology-based training (Nisak & Rahmah, 2024). *Second,* a study that discusses Strategies to improve teacher competence in the digital era for Elementary Schools (Muthmainnah et al., 2025). *Third,* teacher competence in developing Islamic Religious Education based on information technology and communication in Elementary Schools (Norjanah et al., 2022). From these three previous studies, it can be stated that the studies that have been carried out tend more towards strategies for improving teacher competence through information technology-based training, not in Elementary Schools, one of the studies carried out in Elementary Schools did not discuss improving teacher competence through information technology-based training but rather discussed strategies for improving teacher competence in the digital era and teacher competence in developing Islamic Religious Education based on information technology and communication. Studies on strategies to improve teacher competence in elementary schools through information technology-based learning have not been conducted comprehensively.

Teacher competence is a key determinant of the quality of education and student learning outcomes, with a scope that goes beyond knowledge and technical skills to affective domains such as values, attitudes, and motivation (Cilic et al., 2015; Firda & Khairat, 2023; Agustika & Diputra, 2025). There are nine dimensions of competence, including lifelong learning, socio-cultural, emotional, and information and communication technology (ICT) literacy, which significantly shape teachers' roles, decision-making, and performance in the classroom (Nagel & Amdam, 2025). In line with that, Fakhruddin et al. (2023) emphasize four key elements of competence, namely pedagogical, professional, social, and personality, which are the foundation of classroom management and designing effective instructional strategies. In the context of language teaching, Zambak (2024) shows that English teachers are increasingly emphasizing content mastery, responsive classroom management, and the integration of digital technology as part of their evolving professionalism. Overall, these findings indicate that teacher competence is holistic and interconnected across dimensions, and must be continuously developed to align with students' needs and curriculum dynamics.

Information technology learning is now understood to go beyond merely mastering hardware and software, emphasizing the contextual factors that determine the effectiveness of its use across various educational ecosystems. Ethnographic research by Fadlilah et al. (2025) presents the integration of the Technological Pedagogical Content Knowledge (TPACK) approach in Indonesian Islamic schools, showing that religious values and local culture are not obstacles but rather social capital for adapting technology-based learning designs to remain socially and spiritually relevant. In this framework, teaching English as a foreign language can be contextualized through materials, examples, and learning scenarios aligned with community norms. The role of professional learning communities (PLCs) is also crucial as a collaborative vehicle for teachers to formulate culturally sensitive pedagogical strategies, test the use of digital media, and share reflective practices (Fadlilah et al., 2025). In medical education, Gao et al. (2025) show how advances in large language models (LLMs) transform case report articles into interactive online simulations that enrich clinical discussions, deepen diagnostic reasoning, and adapt to the learning styles of the digital generation. This approach creates opportunities to integrate formative assessment, adaptive feedback, and branching scenarios that require data-based clinical decisions. Thus, the quality of IT learning relies on the alignment of technology, pedagogy, and context-sensitive content, supported by collaborative teacher networks and the targeted use of AI.

Improving teacher competence is increasingly positioned as the axis of national education quality reform, with an emphasis on continuous professional development programs that sharpen mastery of material, trigger innovation in teaching methods, and strengthen effective classroom management (Yelfianita et al., 2023). At the education unit level, the participative leadership of the principal transformative emerges as a major lever because it not only encourages teacher involvement in training but also facilitates reflection forums, evaluative discussions, and cyclical performance monitoring through coaching, peer observation, and data-based feedback mechanisms (Al Qadri et al., 2023; Estiani & Hasanah, 2022). A collaborative approach to leadership has been shown to broaden the scope of competence strengthening, reaching professional, pedagogical, and social dimensions while fostering an organizational learning culture (Kemal et al., 2023). In the context of madrasas and elementary schools, principals act as agents of change who map real teacher needs, design relevant capacity-building agendas (e.g., lesson study and microteaching), and ensure their implementation in line with curriculum priorities and student profiles (Fitriah, 2023; Susanto et al., 2024). Thus, adaptive and collaborative leadership acts as an architect of a consistent and focused teacher development ecosystem.

In general, studies on strategies for improving teacher competence in elementary schools through information technology-based learning focus on 3 things: IT training for teachers, the availability of adequate facilities and infrastructure, and structural support from the school. Studies on improving teacher competence are very important. Besides teaching technical skills, information technology-based training also teaches pedagogical strategies that can help teachers integrate technology effectively in learning. Information technology-based training is not only useful in improving teachers' technical competence, but also contributes to improving pedagogical competence. Teachers who are trained in technology use tend to be more innovative in designing learning methods. They are better able to design collaborative, project-based, and interactive learning, which can ultimately increase student motivation and participation. In addition, this training helps teachers develop classroom management skills more effectively, especially in online learning. In situations where face-to-face learning is limited, teachers' ability to manage classes virtually becomes very important (Arlina et al., 2025).

The success of improving teacher competence in elementary schools through information technology-based learning also greatly depends on the existing technology infrastructure in schools. Training will not be effective if technological facilities such as computers, projectors, and internet access are unavailable or limited. Therefore, it is important for the government and schools to ensure that the required infrastructure is available and accessible to all teachers. In addition to infrastructure, another factor affecting the success of training is teachers' motivation and commitment. Teachers who are highly motivated to learn and develop tend to master technology more quickly and apply it in their teaching. Therefore, teachers' internal motivation must always be encouraged through sustainable professional development programs. With structured, sustainable training and adequate infrastructure support, teachers' competence in using information technology can continue to improve. This will ultimately improve the quality of education provided to students, helping achieve the goal of developing high-quality human resources.

Therefore, this study aims to examine the contribution of school principals in improving teachers' information technology (IT) skills at SDN 2 Sampoiniet. In line with this objective, the research questions formulated include: (1) How is IT training for teachers implemented to improve teaching at SDN 2 Sampoiniet?; (2) How does the availability of facilities and infrastructure improve IT-based teacher learning at S SDN 2 Sampoiniet?; and (3) What is the Role of Structural Support in the Implementation of Technology-Based Learning at SDN 2 Sampoiniet?

Method

Research Method and Design

This research uses a descriptive qualitative approach, namely by mapping the information technology competence of elementary school teachers to identify obstacles and needs. The main data were obtained through observations in schools and through searches in digital spaces such as Google. This was done because of the easy access to and abundance of sources on organizational culture, the research's main focus.

Participants and Sampling Technique

This research sample used purposive sampling, comprising principals and teachers selected for their active involvement in policies and actions to encourage the use of IT in schools, as well as teachers who use IT in their teaching. This research was conducted at SD Negeri 2 Sampoiniet in Gampong Ligan over four months, beginning with observation, interviews, and documentation. To ensure data validity, this study used source and method triangulation as verification strategies to assess the data's consistency, credibility, and reliability.

Data Collection Techniques

Data were obtained from the current literature, particularly on school principals' strategies and the development of organizational culture. Other sources included interview and observation results at SDN 2 Sampoiniet, with the Principal and ten teachers as participants. We also collected data online using keywords such as "teacher competence improvement strategies", "elementary school", and "information technology learning".

Data Analysis Techniques

The data was analyzed using the Miles and Huberman approach, which consists of three steps, namely: (1) re-presenting the findings, (2) describing patterns and trends, and (3) understanding the meaning contained. The reduction process focuses on grouping findings related to school principal strategies and organizational culture. Display is done using tables and narratives. Verification is carried out to ensure that the data obtained aligns with the research focus. The entire research process was conducted carefully, taking into account the theoretical framework and context to produce an in-depth, applicable analysis.

Results and Discussion

IT Training for Teachers

Research shows that information technology-based training significantly improves teachers' technical and pedagogical skills. Technically, participants become more proficient in using devices such as laptops and projectors, managing internet connections, and using online learning platforms like Google Classroom, Zoom, and Microsoft Teams to organize course materials, take attendance, assign assignments, and communicate, both directly and indirectly. Pedagogically, teachers become more skilled in designing student-centered learning with the help of multimedia such as videos, simulations, and quizzes. They also implement continuous assessment through digital applications and automated rubrics, and adapt learning to student needs with task differentiation and progress analysis features. The training also improves teachers' ability to understand and analyze data, such as reading dashboard reports, interpreting engagement indicators, and responding to student feedback. This allows teaching decisions such as remediation, enrichment, or material adjustments to be more data-driven. In terms of learning design, teachers' competencies improved in developing lesson plans using the TPACK/SAMR approach, such as transforming traditional presentations into real-time collaborative activities, using breakout rooms for structured discussions, and utilizing adaptive question banks. This positively impacted student participation and learning outcomes.

Furthermore, teachers developed digital ethics and data security awareness, as well as virtual classroom management skills, including polite communication, screen time management, and supervision strategies. Teachers also practiced reflection through digital portfolios and professional learning communities, which collectively strengthened consistency in teaching methods, improved administrative efficiency, and enhanced the quality of classroom interactions. The following table displays images of IT training for teachers at SDN 2 Sampoiniet.

Table 1. IT Training for Teachers at SDN 2 Sampoiniet

No.	Picture	Activity Description
1		Coding & Artificial Intelligence (AI) Training for teachers is designed to equip them with the knowledge and skills needed to develop digital technology.
2		This training, conducted by fellow teachers, aims to improve their knowledge of laptop operation as a digital learning tool. This activity aims to improve teachers' digital competency.
3		Training conducted by fellow teachers to improve the ability to apply projectors and access and use various online learning platforms such as Google Classroom, Zoom, and Microsoft Teams as learning media.
4		Interactive Digital Content Creation: Skills in creating instructional videos, infographics, and multimedia-based teaching modules are becoming increasingly important. Platforms like Canva for Education, Powtoon, and others are often used as primary materials.

5		Mastery of Learning Management Systems (LMS) and Online Learning Platforms: In-depth training on platforms such as Google Classroom, Moodle, and others
6		Training conducted by teachers to help students access and use various online learning platforms, such as Google Classroom, Zoom, and Microsoft Teams, as learning tools.

Based on the table above, the series of digital training activities implemented aims to improve the competency of teachers and students in facing the challenges of education in the technological era. The activities began with coding and artificial intelligence (AI) training for teachers, designed to equip them with insights and skills relevant to developing digital technology. This was followed by training on operating laptops and projectors by fellow teachers, aimed at strengthening basic technical skills in digital-based learning. Teachers were also trained to access and use online learning platforms such as Google Classroom, Zoom, and Microsoft Teams. In addition, they were equipped with skills to create interactive digital content, including learning videos, infographics, and teaching modules, using applications such as Canva for Education and Powtoon. Mastery of Learning Management Systems (LMS) such as Google Classroom and Moodle was also strengthened to ensure efficient online class management. The training series concluded with teachers guiding students to use various digital platforms independently in their learning activities.

Facilities and Infrastructure

The government, along with schools, continues to accelerate the provision of facilities and infrastructure to improve teachers' IT competencies. With the leadership of school principals and the support of education authorities, various policies aim to develop ICT infrastructure, including expanding school internet networks, providing learning devices, and providing technical support, especially in areas lacking these facilities. This synergy aims to ensure adequate access to technology, allowing teachers to participate in digital training in a more easily structured and relevant manner to their learning needs. A collaborative approach among the government, schools, and local stakeholders helps minimize access disparities and strengthens the institution's commitment to building a learning ecosystem that adapts to technological developments. On the implementation side, reliable infrastructure is a key prerequisite for effective technology-based competency development programs (Jayanti et al., 2025). Without stable connectivity, suitable devices, and ongoing maintenance mechanisms, training implementation, digital platform adoption, and ICT integration into learning risk stalling. Therefore, schools need to integrate procurement policies with operational strategies, such as bandwidth management, device usage schedules, improving teacher digital literacy, and providing daily technical support services. This targeted effort not only facilitates teacher participation in training programs but also ensures

consistent transfer of competencies to classroom practice, which ultimately impacts improving the quality of the teaching-learning process.

Table 2. Data on Technology Infrastructure Development Efforts at SDN 2 Sampoiniet School

No.	Aspect	Efforts Made
1	School Policy	The principal determines priority programs for improving the digitalization of learning through the School Annual Work Plan (RKTS).
2	Procurement of ICT Equipment	The school allocates regular BOS funds and committee assistance to purchase laptops, projectors, and active speakers.
3	Improved Internet Access	Schools install Wi-Fi in collaboration with local providers so teachers can access the internet during lessons.
4	Internal Teacher Training	ICT teachers regularly train other teachers on using laptops, Google Classroom, and other online applications.
5	Utilization of Free Platforms	Teachers are increasingly using free platforms such as Google Forms, Canva for Education, and YouTube to create teaching materials.
6	Local Digital Content Creation	Teachers make simple learning videos with simple tools and use the classroom as a recording studio.
7	Periodic Evaluation by the Principal	The principal conducts weekly supervision of technology use in the learning process.
8	School Committee Involvement	The school committee is involved in procuring equipment, including voluntary assistance for cables, device tables, and other needs.
9	Student Guidance	Teachers directly train students to use digital devices such as laptops and projectors in classroom practical activities.

Based on the table above, SDN 2 Sampoiniet has implemented various internal policies to address challenges in developing the school's technology infrastructure, particularly given the limited facilities available. The principal's first step was to prioritize increasing digitalization, which was achieved through the gradual procurement of devices such as laptops, projectors, and internet connections, using the school budget and committee support. Furthermore, the school also strives to collaborate with the private sector and the educational community to obtain assistance with devices and access to training. To expand connectivity, the school strives to install a stable internet network to support online learning and teacher training. Training is also a primary focus, with teachers facilitated to participate in regular online training, both through national platforms and internal teacher-to-teacher activities. The principal also regularly monitors the use of this technology, ensuring that all teachers can independently operate learning devices and platforms such as Google Classroom and Zoom. Furthermore, the school develops simple digital content to support more engaging, interactive learning. All of these policies reflect the school's seriousness about creating a learning environment that is adaptable to technological developments, despite limitations.

Image 1. Computer Lab and Router Internet Network at SDN 2 Sampoiniet

Based on the image above, SDN 2 Sampoiniet has the facilities and infrastructure to support improvements in teachers' IT-based learning competencies. Although it has the facilities and infrastructure, there are still other obstacles in terms of supporting facilities, such as the need for strong electricity and electricity stability in remote areas, which are relatively frequent maintenance (blackouts) by PT Perusahaan Listik Negara (PLN) Persero, which cannot be controlled by the school. This is a challenge for the school to continue implementing information technology-based learning with limited electricity. In addition, not all classes have complete facilities and infrastructure. This is a special concern for the school to address immediately, as it must be used alternately by several classes, disrupting the stability of teaching and learning.

Structural Support

Structural support has proven crucial to the success of technology-based learning in elementary schools: the principal's policy of encouraging the use of IT/ICT, the provision of facilities through the School Operational Assistance (BOS) fund, regular training twice per semester, and collaboration with the education office. This commitment is evident in the policy of requiring teachers to own laptops, which facilitates the creation of teaching materials and increases student motivation through more engaging learning. Despite internet network constraints and power outages, school management responded by strengthening external collaboration and increasing electricity capacity to maintain stable operations. All initiatives are aligned with the school's vision and mission and its commitment to fully support the improvement of teachers' academic and practical competencies. These findings are supported by interviews with the principal and several teachers, summarized in the appendix.

Table 3. Results of Interviews with Principals and Teachers

No	Name	Statement	Coding
1	Teacher 1 (40 Years)	The principal is very supportive of IT use, providing facilities such as computer rooms and internet access, and encouraging teachers to use IT in learning.	Principal Support & IT Facilities
2	Teacher 2 (43 Years)	The principal actively supports teachers by providing IT tools, training for teachers who are not yet proficient, and monitoring and supervising the implementation of IT-based learning.	IT-Based Learning Supervision & Teacher Training in IT
3	Teacher 3 (38 Years)	The principal plays an active role in facilitating teachers' use of IT, monitoring its implementation in class, and is expected to provide IT facilities so they are available in every class.	IT Facilitation for Teachers & Monitoring IT Usage
4	Headmaster (52 Years)	The principal seeks structural support through the procurement of IT equipment with BOS funds, the holding of regular training, collaboration with the education office, and the empowerment of IT-savvy teachers as facilitators.	IT equipment procurement, IT training & IT teacher empowerment

Based on interviews with principals and teachers, it can be concluded that the implementation of Information Technology (IT) in schools has been effective and has improved learning quality (Firmansyah et al., 2025). Principals demonstrated strong commitment through mandatory laptop policies for teachers, the use of BOS funds for IT facilities, and regular training twice per semester. Teachers also experienced the tangible benefits of IT, including the creation of teaching materials and increased student motivation through more engaging, interactive learning. However, limited internet access and power outages remain major obstacles. Overall, school management support,

ongoing training, and collaboration with relevant parties are key factors in the successful implementation of IT-based learning.

IT Training for Teachers

Information technology training for teachers has been shown to significantly improve both technical and pedagogical competencies. Teachers who participated in the training demonstrated improved skills in operating technological devices, such as laptops and projectors, and in accessing and using online learning platforms, including Google Classroom, Zoom, and Microsoft Teams. This aligns with the findings of the study Permana et al. (2024), which states that teacher mastery of technology is a crucial prerequisite for creating adaptive and relevant learning in the digital age. This training not only strengthens teachers' basic technology skills but also encourages them to develop more interactive, efficient, and engaging learning strategies for students.

At SDN 2 Sampoiniet, this training was implemented through a comprehensive series of activities, ranging from coding and artificial intelligence (AI) training to operating digital devices and producing digital-based multimedia content using Canva for Education. Not only is this training focused on teacher development, but it also aims to help students access and use online learning platforms independently. This demonstrates the continuity between teacher competency development and student readiness in the digital learning ecosystem. According to Kudriani et al. (2023) and Permana et al. (2024), a training strategy that touches all elements of the school, including teachers and students, will foster a competitive and sustainable digital learning environment. With the support of facilities such as computer labs and additional projectors, the school has successfully created a technology-based learning ecosystem that is inclusive and adaptable to changing times.

The findings of this study confirm that teachers in the digital era need comprehensive support, including adequate technological resources, access to ongoing training, and institutional support, to fulfill their roles optimally. Teachers function not only as instructors but also as facilitators and developers of knowledge, capable of understanding various important aspects of modern learning. Advances in information technology create significant opportunities to improve teacher competency, provided they are accompanied by ongoing professional training, collaboration with colleagues, and policy support from schools and the government (Khodijah, 2018; Listiyoningsih et al., 2022). Furthermore, awareness of digital literacy, openness to new ideas, and self-confidence are crucial factors in the technology-based educational transformation process. The quality of teacher professionalism also depends heavily on the educational institution's ability to efficiently manage various educational components, which ultimately reflects the quality and effectiveness of the education system itself (Kurniawan, 2023).

Teacher digital competence refers to the ability to understand, use, and integrate technology effectively into teaching and learning activities. This extends beyond operating devices and encompasses leveraging technology to create interactive and meaningful learning (Jalaluddin, 2024; Hermanto et al., 2023). Digital literacy is a key aspect of this competency, requiring teachers to critically and ethically locate, evaluate, and utilize information from various digital sources. Digitally literate teachers not only guide students in accessing information but also instill an awareness of security and responsibility in cyberspace. In this context, basic teacher competencies, including pedagogical, professional, personality, social, and spiritual competencies, are closely related to the ability to integrate information technology into learning. With strong mastery of technology, teachers can create a more engaging, efficient, and relevant learning environment, thereby more effectively achieving learning objectives and the school's vision.

Availability of Facilities and Infrastructure

Improving teachers' competency in information technology-based learning is strongly influenced by the availability of direct support facilities and infrastructure. SDN 2 Sampoiniet is a concrete example of how collaboration among the school, government, and community can help address the region's limited educational infrastructure. As shown in Table 4.2, the principal established digitalization of learning as a top priority in the School's Annual Work Plan. This policy was then implemented by procuring information and communication technology (ICT) devices, such as laptops, projectors, and audiovisual equipment, using regular BOS funds, with active support from the school committee. To ensure continuous internet access, the school also established strategic partnerships with local service providers. Beyond focusing solely on hardware, the school also develops teacher capacity through internal training, weekly supervision by the principal, and the use of free digital platforms such as Google Forms and Canva for Education for teaching and learning. This comprehensive approach demonstrates that improving teacher competency is inseparable from consistent institutional policies, ongoing training, and adequate infrastructure, as emphasized by Wati & Nurhasannah (2024) and Widana (2020).

However, technical challenges remain a significant obstacle to the smooth implementation of digital learning at SDN 2 Sampoiniet. One of the main issues is an unstable electricity supply due to periodic PLN blackouts, which directly affects the continuity of online activities and the use of digital devices in the classroom. Furthermore, the limited number of ICT devices requires several classes to share facilities, ultimately disrupting the effectiveness and continuity of teaching and learning. This condition reflects a broader challenge: elementary schools in the 3T (frontier, outermost, and disadvantaged) regions face unequal access to adequate digital infrastructure. Miftah & Fahrurrozi (2022) highlighted that this gap is a major obstacle to efforts to equalize the quality of technology-based education in Indonesia. Therefore, policy interventions are needed from both local and central governments, including the procurement of ICT devices through school digitalization programs, the provision of alternative power sources, such as generators or solar panels, to address power outages, and the construction of digital classrooms that meet standards. The adaptive strategy implemented by SDN 2 Sampoiniet can serve as an initial model, further developed through cross-sector support, to realize an inclusive, equitable, and sustainable digital education ecosystem.

The Role of Structural Support in the Implementation of Technology-Based Learning

Structural support provided by school management, particularly the principal, plays a central role in the successful implementation of Information Technology (IT)-based learning in elementary schools. Interviews indicate that the principal of SDN 2 Sampoiniet serves not only as an administrator but also as a driving force for digital change within the school. Concrete policies such as mandating laptop ownership for every teacher, using BOS funds for technological infrastructure, and providing twice-per-semester training reflect a vision focused on improving the quality of learning through IT. This aligns with research by Nisa et al. (2025) and Supardi et al. (2025). The principal's visionary and transformative leadership is a key factor in driving digital learning innovation. This structural commitment is also evident in the school's collaborative approach, such as collaboration with the education office and the involvement of the school committee to support the comprehensive digitalization program. This approach not only increases teachers' technical capacity but also fosters a more adaptive and technology-friendly learning culture.

In the field, teachers at SDN 2 Sampoiniet stated that IT-enabled learning has become an integral part of their daily activities. Teachers utilize technology to develop teaching materials, visualize concepts, and create more interactive and engaging learning for students. Positive impacts have also been observed in student motivation and participation, which have increased significantly through the use of varied digital media. This finding is reinforced by Jamun et al. (2023), who state

that IT integration in learning not only improves teaching effectiveness but also strengthens students' emotional and cognitive engagement. However, obstacles such as limited internet access and power outages remain technical barriers that need to be strategically addressed. The principal has addressed this issue by increasing electrical power as a temporary measure, but support from higher-level stakeholders is still needed to ensure the sustainability of this digitalization program. Overall, the successful implementation of IT in this school demonstrates that strong structural support, coupled with ongoing training and infrastructure strengthening, can drive meaningful learning transformation, even amid limitations.

Overall, this study offers new insights into how transformational leadership style, collaborative strategies, and infrastructure conditions affect the success of technology-based learning implementation in elementary schools. Unlike previous studies that focused more on teacher capabilities or facility availability alone, this study's findings show that the success of digital transformation is greatly influenced by the principal's ability to build a digital culture, leverage external support, and develop creative solutions when resources remain limited. An important contribution of this study is the identification of the adaptation patterns employed by schools, namely the gradual procurement of devices, training in Canva and artificial intelligence, and a device-sharing system that enables digital learning to continue. Th The respondents from SDN 2 Sampoiniet were the principal and three teachers, providing an in-depth picture of technology implementation in elementary schools. Thus, this study offers a new perspective: digital transformation in elementary schools depends not only on technology but also on visionary, collaborative, and responsive leadership.

Conclusion

This study found that the IT-based teacher competency improvement strategy at SDN 2 Sampoiniet significantly improved the effectiveness of the learning process through continuous IT training, the availability of digital facilities and infrastructure, and structural support from the principal, which strengthened the digital culture. Theoretically, this study reinforces the idea that digital transformation requires synergy among teacher competence, leadership, and infrastructure, and expands the study of TPACK implementation in elementary schools. In practice, the results of this study recommend developing more adaptive IT training programs, optimizing BOS funds for ICT procurement, and strengthening collaboration among schools, local governments, and school committees. However, the limitation of this study is its scope, which covers only one school, so generalization should be done with caution. For further research, it is recommended to conduct comparative studies across regions and use quantitative or mixed-methods approaches to analyze the effectiveness of school digitization policies more objectively and longitudinally.

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